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ERWIN F. SMITH

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(WITH PLATE 20)

Dr. Smith's span of life covers a period of swiftly changing ideas and rapidly mounting achievements in the history of plant pathology in America. He saw its birth as a science; he, himself, contributed more than any other one man to its mature development; and, what is rarely experienced by creative genius, he lived to see it secure in its position among the sister sciences. Surely an enviable record!

At the time of their early studies of bacteria in relation to human and animal disease, Pasteur and Koch found the state of knowledge sadly chaotic and conflicting. At the same level Smith encountered the problem of bacterial disease in the realm of plant life. In those first years he fought the battle almost single-handed, but the foundations which he laid back of these early steps were so sound and secure that they have withstood the tread of many later generations.

My own association with Dr. Smith began at a time just succeeding the publication (1907) of his first memorable contribution on plant cancers of bacterial origin. The introduction to him well illustrated his characteristic human interest in everybody, and especially in those who were earnestly engaged in any honest endeavor. It had fallen to him to grade my Civil Service examination paper, without of course knowing to whom it belonged. Some weeks later he chanced to see a slip of paper in my handwriting and, noticing at once the similarity, asked that

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the writer be found and brought to him. I shall never forget that first meeting—the light in his eye, known to his friends but never shown in his photographs, the kindly interest and advice, the sincere invitation to come again and again—a meeting which led the way to long years of association, through which I learned to honor him as one of the great men of science and to love him as a father.

Toward the group of workers immediately under his charge he was almost patriarchal in attitude; there was always the close relationship on the human side. He loved to have the whole group at his home; we were often there and always welcome—at Christmas, on Thanksgiving Day, and on many other occasions. After the meal he often exchanged reminiscences or read to us gems of his own more recent sonnets. We had all read his book of sonnets and translations published in 1915 and we knew that another volume was on the way. He was expert in pencil drawings and the woodcuts in this first book of sonnets were by his own hand. His pencil drawings were made with extreme care and, with his eye trained to note details instantly, were useful adjuncts to his scientific work, especially in the earlier years.

He was always giving a helping hand to somebody; his generosity was nothing short of phenomenal. Today it might be a needy fellow scientist in Austria; tomorrow, an injured watchman in the building where he worked. Any youngster with a whit of sense and ambition was sure of an audience with him, and many a struggling youth he helped through school. To any worthy person or object he was ready to give of himself and of his means.

Toward woman's suffrage he lent his support from the first. He always believed that women should be given a fair chance in science, and this at a time when such opportunities were rare outside the teaching profession.

However reticent he might be toward outsiders about giving out professional secrets prior to publication, he was always freely communicative to members of his own staff, and not only with results already obtained but also regarding his ideas, plans, and hypotheses for future investigation.

As to essentials, he was one of the most modest of men, often to the point of shyness or even discomfort; yet in very minor points of detail he was sometimes quite exacting as to his due. On expressing my deep appreciation at the opportunity of becoming one of his group of workers he said: "I am afraid you will be disappointed for I am not as big a man as you think I am." More recently, when one of the members of his staff had urged him strongly to write an autobiography, he replied: "There is nothing in my life to interest anybody." And these statements were made in all sincerity and with no least hint of affectation.

His intense love of art in all its forms—music; literature; poetry; painting; sculpture; vases, of which he collected many—was well known to all his friends. Anything in brilliant colors made to him a great appeal. He loved the flaming reds of canna and scarlet salvia; and yet he possessed also a keen sense for slight differences in color.

In later years the terraced garden on the steep hillside back of his house was a source of keen delight and pride to him. Walking and sawing cord wood were his favorite forms of exercise.

He loved children, dogs, and jokes, especially those on the Scotch. Next door, two children who had lost their father found in him a true friend. He loved to talk with them and tell them stories, and many a book was received by them from his hand. Just before his marriage in 1914, one of these children was heard to remark: "I wonder if it will be the same as it was or if it will be as if he had never been."

His interests were as wide as the world and wider. One day he went into a Boston bookstore and asked to be shown all the books on Italy. Before leaving he had purchased thirty! On another occasion he bought copies of all the periodicals sold in the bookstalls along the Seine in order to find out what was being offered to the Paris public. He took the London Times and the Manchester Guardian. More recently, he subscribed to the Congregationalist, having read an article and editorial on evolution following the Bryan controversy—"For," he said, "any religious journal that is open-minded enough to print such an article is the kind of journal that I want to support."

His ancestors were pioneers and frontiersmen who felled many

a forest and subdued many a stony field. They helped to settle half a dozen towns in eastern Massachusetts and then moved on into the wilds of Connecticut, afterwards into Central New York, and still later into Southern and Central Michigan—always pushing the frontiers farther and farther back. How typical of the scientific frontiers conquered by their illustrious descendant!

Of his upwards of two hundred scientific contributions,¹ little need be said here; they are too well known throughout the world of biology to require detailed comment. The breadth of his scientific viewpoint is attested by the fact that he published in English, German and French in journals of such diverse interests as the *Centralblatt für Bakteriologie*, *Science*, *Reports of the Royal Horticultural Society*, the various series of the United States Department of Agriculture, *Compt. Rend. 1er Congrès International de Pathologie Comparée*, *Proceedings of the International Congress of Medicine*, *Journal of Cancer Research*, *Journal of Bacteriology*, *Proceedings of the National Academy of Sciences*, *Johns Hopkins Hospital Bulletin*, *Brooklyn Botanic Garden Memoirs*, *Archives of Dermatology and Syphilology*, *Phytopathology*, *Journal of Radiology*, *Journal of Infectious Diseases*, *Revue de Pathologie Végétal et d'Entomologie Agricole*, *Revue Botanique Appliquée et d'Agricultur Coloniale*, *Revue Générale des Sciences Pure et Appliquées*, *Journal of the Washington Academy of Sciences*, *Journal of Heredity*, *Scientific Monthly*, *American Naturalist*, etc. His textbook, an *Introduction to Bacterial Diseases of Plants*, and his three-volume monograph on *Bacteria in Relation to Plant Diseases* are well known to bacteriologists in general. It is not so well known that of the latter he had other volumes in preparation. The translation of Duclaux's life of Pasteur has won unstinted praise from scientist and layman alike.

In his scientific researches he had that rare ability of sensing when he should forge ahead and when he should call a halt. This trait is evidenced by his reply to a written query from a fellow scientist. "I was rather amused," he wrote, "at your

¹A complete bibliography has appeared in the October, 1927, issue of *Phytopathology*.

questions concerning my investigations on peach yellows and my reasons for stopping. When I was a young man and came to the Department of Agriculture, I requested them to give me the most difficult problem which they had. They assigned me the subject of peach yellows. This was my reason for undertaking the investigation. The reason that I gave it up was that I was tired of butting my head against a stone wall." It is worthy of comment that the state of knowledge regarding this disease remains today essentially where Smith left it.

A history of the bacteriology of plant diseases could not be written with Smith left out of the picture; yet perhaps he will remain best known to biologists as a whole through his monumental investigations of the general cancer problem—in animals and man as well as in the realm of plant life. His position here is perhaps best expressed in the words of Dr. William H. Welch, addressed to Smith himself at the testimonial dinner given in his honor by the American Phytopathological Society in Philadelphia, December, 1926: "No one in our day has done more to bring these two great divisions of pathology into closer relation to their mutual advantage. . . . Above all, your studies of tumors of plants, which you have demonstrated to be of bacterial origin, have brought you into the field of oncology in its broadest aspects. Here you take your place in national and international congresses and associations devoted to cancer research or to medicine in general, and here your work is recognized as of the greatest interest and importance. While your name is associated especially with the championship of the parasitic theory of the origin of tumors, your studies of the mechanism of tumor formation, of problems of histogenesis, of formative stimuli and inhibitions of growth and other kindred subjects are scarcely of less importance. . . . We, too, on the medical side, as well as your own more immediate colleagues in plant pathology, have had opportunities of close association and have learned to admire you as a man inspired with the highest ideals of the searcher for truth in nature and devoted to this search with the heart, the methods and the loyalty of the ideal man of science." It need only be added that in 1924 Smith was elected president of the American Society for Cancer Research—a most unusual honor to

be accorded a man engaged primarily in the field of plant research.

Those interested in Dr. Smith's philosophy of life I can perhaps best refer to his address,² "Some Thoughts on Old Age," delivered as guest of honor at the annual dinner of the Botanical Society of Washington, in 1924, and epitomized in the following sonnet given at the close:

AT SEVENTY

Backward I look from the summit of the years
At the rugged dusty way of toil and grime,
From level distant plain of boyhood's prime,
—Way strewn with hopes, with triumphs and with tears;
And I am optimist, like him who hears
Clear voices call from higher peaks of Time,
Across the cloudy glens, and turns to climb
What yet remains, with more of hopes than fears.
I'm but a grain of sand upon Time's shore,
Driven by wind and water evermore!
And *millions* make but shifting dunes and bars!
Yet I can read in every grassy sod,
Divine great thoughts that sweep beyond the stars
And make me one with Him who is our God!

To the world of science and to his friends it will never "be as if he had never been."

BIOLOGICAL ABSTRACTS,
UNIVERSITY OF PENNSYLVANIA

² Jour. Washington (D. C.) Acad. Sci., 14 (11): 231-238. 1924.

BIOLOGIC STUDIES IN THE SPHAERIALES—I¹

JULIAN H. MILLER

(WITH PLATES 21 AND 22 AND 3 TEXT FIGURES)

The fungi which constitute the object of this investigation are included in the Sphaeriales by Lindau (16). This order, together with the Perisporiales, Hypocreales, Dothideales, and Laboulbeniales, compose the Pyrenomycetes, an enormous assemblage of forms distinguished by the type of ascus conceptacle which is called the perithecium.

The orders of the Pyrenomycetes are separated by most mycologists in the following manner. The Perisporiales comprise forms in which the perithecia remain closed or have an atypical opening. The Hypocreales have fleshy, bright-colored or colorless perithecia which, though sometimes brown, are never black and hard. In the Dothideales the asci are formed in locules in a stroma, and true perithecia are lacking. In the Sphaeriales plainly differentiated leathery, hard, or carbonaceous perithecia occur with or without an accompanying stroma. Finally, the Laboulbeniales have perithecia, but lack a true mycelium.

The application of these separations has resulted in bringing together clearly unrelated fungi, due in part to a misconception of the fundamental differences between the perithecium and the stroma.

It should be emphasized then that in the Sphaeriales the asci are borne in perithecia, and this order is separated from the Dothideales by the fact that in the latter the asci are located in

¹ Also presented to the Faculty of the Graduate School of Cornell University as a major thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

This investigation was accomplished under the direction of Dr. H. M. Fitzpatrick, to whom the writer wishes to express his appreciation for his suggestions and continued helpful supervision of the problem. The writer is also indebted to Dr. L. Massey for making available the herbarium and the facilities of the laboratory, and to Prof. H. H. Whetzel for much inspiration and encouragement in the prosecution of this investigation.

cavities or locules in a stroma. In reality this separation has been used only when there are two or more locules or perithecia in the stroma. Species in which only one locule is present have been placed in the Sphaeriales, there being no method known for differentiating an unilocular stroma from a true perithecium. This order, as generally delimited, contains consequently many forms which are properly placed in the Dothideales.

Many modern writers have recognized the presence of these unilocular forms in the Sphaeriales, and some, *e.g.* von Höhnelt (10, 11, 12, 13, 14, 15), and Theissen and Sydow (28, 29), have contributed a mass of evidence which will aid in the development of a more natural arrangement. While these investigators have uncovered characters that clearly distinguish unilocular stromata, they have failed to recognize the fundamentally important difference in development between the tissue constituting the boundary of the locule and a true perithecial wall, or the correlated difference in ascigerous development. This has led these investigators, along with Petrak (21) and Gäumann (7), into the error of assuming that within any given group of dothideaceous forms a perfect series of transitions into the Sphaeriales can be attained by selecting ones with consecutively thinner walls. According to them the unilocular form with an uniformly thin wall, even though the interior of the locule be of the dothideaceous type, falls in the Sphaeriales.

The purpose of this investigation has been to demonstrate differences in development between the Dothideales and the Sphaeriales, which hold for all forms, including those with one locule and those with one perithecium in the stroma; and to show that when the dothideaceous forms are removed from the Sphaeriales the remaining species will constitute a definite series of related forms.

Explanation of Terms

Stroma. The vegetative matrix called the stroma, which functions in the storage of food for the development of the fructification which later arises in it, is a common and variable structure in the Ascomycetes.

The limits of the term stroma have been defined variously by different investigators. Orton (19) summarizes the concepts of

Persoon (20), Tulasne (30), Fuisting (5, 6), Ruhland (24), and others. Persoon introduced the term in connection with the genus *Sphaeria* and applied it to the structure in which the perithecia are borne. Tulasne employed it for the body in the family Xylariei, which forms first conidia, and after further development perithecia.

Fuisting and Ruhland distinguish different types of stromata in those groups of the Sphaeriales in which this structure contains more than one perithecium. The former writer, in the case of *Nummularia Bulliardii* Tul., distinguishes a hyaline, pseudo-parenchymatous crust, found in the outer layers of the primary cortex of the host, which produces conidia. He terms this the **epistroma**, and says that it functions both in rupturing the bark and in producing conidia. Under this crust a **hypostroma** is produced, in which later perithecia are developed. Ruhland follows the conception of Fuisting, but uses instead the terms **ectostroma** and **entostroma**, respectively.

Ruhland recognizes further differentiation in the two layers. He designates the ostiolar disk by the term **placodium**; and since, in forms like *Diatrype disciformis* Fries, it originates from the entostroma, he characterizes this type as **entoplacodial**. He then traces transitions from the entoplacodial type to his **ectoplacodial** type—through which the entostroma becomes reduced and the placodium is formed in part at least from the ectostroma. Where both ectostroma and entostroma are present he terms the body **diplostromatic**, and where one only is present, **haplostromatic**. Therefore, with the types with reduced entostroma it is but a step to his haplostromatic type, in which the entostroma disappears entirely, and the perithecial initials develop within and near the base of the ectostroma. He says the Xylariaceae belong to this type, and thinks these are the highest forms in the Sphaeriales.

Wehmeyer (31: 579) defines the stroma as "an aggregation of vegetative mycelium not resulting from a sexual stimulus." He excludes the tissue composing the perithecial wall and centrum (ascigerous portion), the tissues of the apothecium, and the purely nutritive mycelium which is neither definitely aggregated nor coalesced. As sclerotia and other sterile masses, not associated with spore-bearing structures, are identical in their histo-

logical nature with the matrices of various compound fruit-bodies, they fall within the limits of the definition. Wehmeyer (31: 580) says, further, that he uses the terms ectostroma and entostroma to designate differences in structure and position and not in function, and defines them as follows: "An ectostroma in the Pyrenomycetes is that portion of the stroma which is formed on the surface of the bark, beneath or within the periderm, and which consists typically of fungous tissue only, except that when it is developed within the periderm it may contain the remnants of periderm cells, but never of the bark cortex cells. An entostroma is that portion of the stroma which develops within the cortical or woody tissue of the host or substratum, and is made up of components of both fungus and host tissue or substratum."

The writer feels that these definitions of ectostroma and entostroma are not comprehensive enough to include all Pyrenomycetes, or even all members of the Sphaeriales. Wehmeyer says that they designate differences in structure and position, but he uses them to designate differences in position only, *i.e.* ectostroma in periderm, entostroma in cortex. His definitions are clearly limited to forms in the Allantosphaeriaceae and the Diaporthaceae which occur on hosts with periderm, and are not applicable to forms which occur on monocotyledonous hosts, or on decorticated wood or leaves. Furthermore, in the Xylariaceae, while the entostroma is initiated in the cortex, or woody tissue of the host, it is composed of fungous tissue alone. This type of entostroma would not come within the scope of his definition.

According to Gwynne-Vaughan and Barnes (8: 1), a stroma is defined as follows: "In most cases the hyphae are richly branched; they elongate by apical growth, and, as a rule, spread loosely through the substratum; in some cases, and especially in relation to the fruit bodies of higher forms, they become woven into a dense mass which in section gives the appearance of a tissue, and is therefore described as pseudoparenchymatous; such a mass, when not forming part of a single fructification, is termed a stroma;" This definition is applicable to forms in which there is more than one locule or perithecium in the stroma, and evidently does not include the forms with only one locule or perithecium in the stroma.

In this paper the term stroma will be used to include fungous bodies which are formed of coalesced hyphae, which do not arise as a result of a sexual stimulus. There is apparently a tendency toward the reduction of the sexual apparatus in the Ascomycetes. Nevertheless, the ascospore has always been considered the sexual spore. Its sexual nature has been demonstrated in many cases. Therefore, to the writer, it seems logical to term the body which arises from the archicarp and bears ascospores the sexual fructification, in contrast to the stroma. In the Sphaeriales the body (perithecium) which arises from the archicarp (including wall, ascogenous hyphae, asci, paraphyses and periphyses) is a distinct generation in the life cycle of the fungus, and is just as truly distinct from the other generation (mycelium and stroma) as the sporophyte is distinct from the gametophyte of a higher plant. In *Sclerotinia*, the sexual fructification (the apothecium) arises from an archicarp in the sclerotium. The sclerotium is therefore a stroma. In *Claviceps* the perithecia are the sexual fruit-bodies and the rest of the structure, including the sclerotium, is stromatic. In *Rosellinia aquila* (Fries) De-Not. (TEXT FIGURE 1) an extensive stroma often develops under the



FIG. 1. *Rosellinia aquila* (Fries) De-Not. Longitudinal section through a mature perithecium and stroma. This photomicrograph shows a perithecium in the upper part of an entostroma and oriented under a definite ectostroma.

periderm. This ruptures the bark in places, and develops further perpendicularly to the substratum. An archicarp then arises in

the external part and develops into a perithecium. It could not be said that the portion of the stroma that grows out through the ruptured bark, and in which the perithecium is formed, is pushed out as a result of a sexual stimulus. The sexual stimulus is in the archicarp, and the latter arises after the stroma has grown out. In *Claviceps*, *Cordyceps*, and certain species of *Xylaria*, which arise from a sclerotium, the archicarps are found in the periphery of the vertical structure and not in the sclerotium. Therefore, it seems illogical to say that the vertical structure arises as a result of a sexual stimulus. This structure is merely a continuation of the sclerotium and the whole tissue is a stroma.

The terms ectostroma and entostroma are useful in dealing with the Sphaeriales. The former will be limited to the part of the stroma first formed in or on the periderm, or on the wood when the bark has been removed, which functions in rupturing the bark when the latter is present and which usually functions in producing conidia. The term entostroma will be applied to the portion of the stroma which develops under this and bears perithecia in its periphery. The entostroma in most of the forms studied by Wehmeyer consists of stromal elements mixed with wood and, in the sense of a pseudoparenchymatous tissue, is certainly not a true stroma. It often has been termed a valsoid stroma. The writer considers it a primitive type of entostroma. In the Xylariaceae the effused forms, such as *Nummularia*, represent the minimum of entostromatic development, and certain species of *Xylaria* the maximum. In fact these two genera differ only in the amount of entostroma. The ectostroma is the primary outer layer in both. Also in the Allantosphaeriaceae and Diaporthaceae, as compared with such a form as *Hypoxylon coccineum* Bull., there is very little entostromatic development.

In the Sphaeriales and Hypocreales, forms such as *Rosellinia* and *Melanospora*, in which the perithecia are single, have not been previously considered as stromatic. In the early development the archicarp gives rise to a coiled ball of fine hyphae which forms the perithecial wall, asci, paraphyses, and periphyses. The surrounding tissue, which is large-celled and pseudoparenchymatous in type, and which may exist later merely in a fragmentary

state on the outside of the wall, is certainly stroma. In fact the perithecium in these two orders is, contrary to previous conceptions, apparently always formed within a more or less well-developed stroma.

In the Dothideales the sexual fructification consists of the group of asci and the hymenial layer from which they arise. The rest of the tissue making up the structure is clearly stromatic. This has never been a matter of dispute.

The perithecial wall. The Sphaeriales have been considered by all mycologists as having an ascigerous cavity bounded by a definite perithecial wall, in contradistinction to the Dothideales, where the cavity lacks the wall. In compound fructifications this difference has been clearly recognized, but the unilocular forms in the Dothideales, and the uniperithecial ones in the Sphaeriales, have resulted in much confusion.

Von Höhnelt (10, 11), Theissen and Sydow (29), and others have attempted to consider, together with unilocular forms, those plurilocular forms in which each locule fills an arched-up portion of the stroma resembling externally a perithecium. They segregated these in the Pseudosphaeriaceae v. Höhnelt (Pseudosphaeriales Th. & Syd.). They adopt as a basis for the separation the character² of the interior of the so-called cavity. Neither these writers nor Gäumann (7) take into consideration the ontogeny of a true wall. Gäumann for instance places *Botryosphaeria* in the family Dothioraceae of the Myriangiales, and asserts that the asci are arranged in locules in the stroma. Then in regard to the development in this family he says (page 214) that such forms as *Botryosphaeria Bakeriana* Rehm, *B. Quercuum* (Schw.) Sacc., and *B. Ribis* G. & Dug. have attained the highest level, because here the locules appear to be in process of separation, and finally in some cases contain only one locule resting on a stromal base. He then says these latter, isolated forms have their own walls, and so have become perithecia. Clearly, then, his definition of a wall, like that of most mycologists, is based on a gross morphological conception, which does not take into consideration the origin of the wall. The writer has found that in *B.*

² Von Höhnelt terms the mass of asci, etc., which fill the cavity of the perithecium, the perithecial nucleus, but the writer will use the term perithecial centrum or locule centrum, avoiding this incorrect use of the term nucleus.

Ribis the size and form of the stroma are dependent on characters of the substratum, such as thickness of bark, firmness, etc. Where the bark is thick the stromata are thick with many locules, and where the bark is very thin the stromata become increasingly thinner with a tendency to be unilocular. Gäumann (7: 284) says, further, that among the higher Scolecosporeae of the Hypocreales stromatic forms without perithecial walls arise from stromatic forms with solitary perithecia. This causes him to question the correctness of recognizing the group Dothideales. It would seem from this that he thinks that the presence or absence of a true wall is of no systematic significance. In the Hypocreales the writer has examined no species in which the ascigerous cavity lacks a true wall. The species placed in the genus *Ophiodothis* of the Dothideales by Saccardo (25: 652), including species of *Dothichloe* Atk. and *Myriogenospora* Atk., have distinct perithecial walls, and are related to *Balansia*, *Hypocrella*, *Claviceps*, and *Cordyceps* in the Hypocreales. Theissen (28: 187) has called attention to this fact.

To the writer the perithecial wall seems to afford a character which is definitely correlated with characters of the perithecial centrum; and the forms possessing it stand in sharp contrast to the dothideaceous fungi in which it is lacking. The characters that accompany the lack of a perithecial wall are the presence of pseudoparenchyma in the centrum, absence of paraphyses and periphyses, the convex to flat or concave form of the hymenial layer, and the lysigenous type of the opening. When there is a true wall there is no pseudoparenchyma in the centrum, there are true paraphyses and periphyses, concave hymenial layer, and the ostiolum is shizogenous in type. The wall in the Sphaeriales is histologically and ontogenetically different from the tissue of the stroma. The writer will define it as the specialized tissue, which arises from the archicarp, and from the beginning encloses the ascigerous centrum. None of the cells of the wall are derived from those of the stroma other than those of the archicarp. Certain previously published evidence corroborates this view.

Gwynne-Vaughan and Barnes (8: 234, FIG. 186) represent a single hypha, the archicarp, which initiates the whole perithecium in *Xylaria polymorpha* (Pers.) Grev. They say: "If the stroma

of *Xylaria* or *Hypoxyton* is sectioned during the conidial stage, nests of small hyphae are found, and form the first indication of perithecia (FIG. 185). Still earlier a stout hypha with large nuclei, presumably an archicarp, is recognized." The writer will show later that in *Hypoxyton* the primary coil, or archicarp, arises as a single hypha in the stroma. In its later development its external cells coalesce to form the perithecial wall, while its central cells give rise to asci and paraphyses. Therefore, in a true perithecium, the layer of asci, including the paraphyses, is directly connected with the wall. The writer has often succeeded with macerated stromata in getting the perithecium out intact and free from stroma. If the wall were only a modified inner layer of the stroma, that would be impossible.

In the Erysiphaceae also the wall arises from the archicarp. Hein (9: 391) says: "The enveloping hyphae arise just below the septum which cuts off the oogone from the basal cell and at a corresponding level from the basal cell of the antherid."

Also the apothecium of the Discomycetes arises entirely from the archicarp. In regard to *Pyronema confluens* Tul., De Bary (1: 208) says: "Copiously branched hyphae begin to shoot out from the sterile branches of the archicarp, and from the whole of the rest of the basal region of the rosette to form the envelope portion of the sporocarp."

This explanation of the significance of the wall has been given in detail, because only by having its origin clearly in mind can one easily separate unilocular dothideaceous forms from those with true perithecia.

The genus *Guignardia* affords a case in point. This genus has been placed in the family Mycosphaerellaceae of the Sphaeriales, and the perfect fruit-body has been thought to be a true perithecium. Theissen and Sydow (29) noted that the asci arise in a homogeneous pseudoparenchyma in the Mycosphaerellaceae in the same manner as in the Dothideales, and they placed this family in their order Pseudosphaeriales. Von Höhnelt (12: 629) says: "Die Gehäuse der Sphaerella-arten sind keine Perithezien sondern kleine (meist) einhausige, peritheziennährliche Stromata. Solche Gebilde nenne ich Dothithezien." In regard to the origin of the asci in *Guignardia*, Reddick (23: 311) says: "Such peri-

thecia are surrounded by the usual thick, black, pseudoparenchymatous covering. This pseudoparenchyma becomes thinner walled inwardly, so that the whole interior of the perithecium is filled with it. In the stained sections there are scattered here and there, near or a little below the center of the perithecium, little dots, of much deeper staining quality, which in well bleached preparations are seen to be individual cells when examined with an immersion lens. . . . When activity begins, the ascogenous cell elongates by pushing its way upward, though at the very first it seems to take the path of least resistance and may grow in a longitudinal direction for some distance." He found very young stromata composed of homogeneous pseudoparenchyma, which he termed pycnosclerotia, and he thought they were sporeless pycnidia, which may eventually develop into perithecia. In examining his preparations the writer finds, as stated above, that in the earliest stage seen the so-called perithecium consists of a homogeneous pseudoparenchymatous matrix, in which a little below the center the archicarp arises. At this stage the condition is identical with that shown by the writer for *Hypoxylon* (PLATE 22, FIG. 7). But in *Guignardia* (PLATE 21, FIG. 4) as the asci develop, the tissue directly above disintegrates, and the asci push up between the fragments. In the Sphaeriales (PLATE 22, FIG. 6) the archicarp very early gives rise to a wall, which definitely shuts out all the pseudoparenchyma of the stroma. In *Guignardia* the archicarp gives rise to no wall, and so has exactly the same type of development found within the Dothideales.

The ostiolum. There seems to be no general agreement among mycologists as to the limits of this term. Some would apply it to any pore of an ascigerous or pycnidial fructification through which spores are liberated. Others apply it to the papilla or neck of the conceptacle.

Wehmeyer (31: 582) says: "The ostioles are merely the erumpent portions of the perithecial necks." Von Höhnelt (15: 138), in regard to the Coronophoreen, characterizes them as having no ostiola, and places them in the Allantosphaeriaceae, all the other members of which have ostiola. Toro (26: 40) created the order Pseudoperisporiales on two genera, *Porostigme* Syd. and *Pseudoperisporium* Toro. He says: "The order

differs from the Perisporiales in having perithecia with definite ostiola." If the conception of an ostiolum is of such taxonomic value, it should certainly not mean different things to different mycologists.

De Bary (1: 190), speaking of perithecia, says: "They are bounded on the outside by the wall, which encloses an ascigerous hymenium, and are furnished in the full-grown state with a narrow aperture or ostiole, which is a canal passing through the wall, and serving for the discharge of spores. . . . The ostiole is not formed till the development is more advanced, and it appears as an intercellular passage in the originally closed tissue; it is partly schizogenetic by the separation of persistent tissue elements in consequence of unequal growth, partly lysigenetic by the dissolution of a strip of tissue lying originally in the canal."

Most writers seem to agree that the opening in the Dothideales does not constitute an ostiolum. Gäumann (7: 284), in discussion of this order, says that, from the lack of a special perithecial wall, there follows the lack of an ostiolum, and the summit of the locule is always formed through a definite part of the stroma regardless of the shape of the summit. So he thinks that the lysigenously formed pore in the summit of the stroma does not constitute an ostiolum. Theissen and Sydow (29), in regard to the Pseudo-sphaeriales, say that an ostiolum is not present. They apply this point of view then to such forms as those in the Cucurbitariaceae, Pleosporaceae, Mycosphaerellaceae, as well as to those in the Dothideales. Blain (2: 17), in his study of the dothideaceous stromata, says: "No definite ostiole has been found in the study of the fungi involved in this paper except those which obviously belong to the Sphaeriales."

The writer will consider as an ostiolum the canal passing through the papilla, or neck of the perithecium, and terminating in a pore. It is lined with minute periphyses, which are outgrowths of basal cells in the neck wall and have free ends. The pore is formed by the pulling apart of wall tissue at this point due to unequal growth, and the canal is formed by the upward growth of the wall. It is never formed lysigenously as in the Dothideales. In this conception the term ostiolum is clearly limited to the perithecium of members of the Hypocreales and Sphaeriales.

The latter part of De Bary's definition is applicable to the Dothideales and Pseudosphaeriales. In both cases there is a dissolution of a strip of pseudoparenchymatous tissue directly above the asci, which results in an opening, but the tissue lining the canal is histologically stroma, and not wall tissue as in the Sphaeriales. These two methods of forming the canal are so distinct that it would certainly not be accurate to use the term ostiolum for both.

Paraphyses. This term has been applied to sterile threads lying between the asci in a parallel position. However, since such threads are known to arise from different sources, it is necessary to define the term more definitely.

Petrak (21: 67), in discussing the evolution of paraphyses, considers those found in both types of centra, *i.e.* the Pseudosphaeriales or the Dothideales on the one hand, and the so-called Diaportheen³ centrum on the other. The first type of centrum he divides into three categories: (1) Paraphyses completely lacking, examples *Mycosphaerella*, *Sphaerulina*, and *Guignardia*. (2) Paraphyses more or less thread-like and cellular, entirely atypical, formed from compressed parts of the ground tissue. As examples he cites *Weltsteinia*, *Pseudosphaeria*, *Botryosphaeria*, *Dothiora*, *Pleospora* sp., and *Leptosphaeria* sp. He calls these paraphysoiden, and says they are entirely primitive forms of paraphyses. (3) Paraphyses more or less strongly developed and branched, not at all, or scarcely gelatinizing, grown above to the covering tissue of the perithecial membrane. As examples, he designates *Leptosphaeria* sp., *Melanomma* sp., *Trematosphaeria* sp., *Massarina*, *Massaria*, *Pleomassaria*, and many others that he considers as belonging to the Sphaeriales, as well as numerous dothideaceous fungi.

He follows this with his Diaportheen type. In this type of centrum there is no pseudoparenchyma. He divides this into three groups: (1) Pseudoparaphyses completely lacking. Here he puts most of the genera of von Höhnelt's (13: 631) Diaportheaceae, also *Valsa*, and *Melanconis* sp., "but no single Dothideales form." (2) Pseudoparaphyses rather numerous, cellular, rela-

³ The term "Diaportheen centrum" is used here in the broad sense to include perithecia with true paraphyses and asci lining the base and sides, and genuine ostiola lined with periphyses.

tively broad, usually delicate, and at early stages strongly gelatinizing. He gives, as examples of this type, many species of *Melanconis* and *Pseudovalsa*. (3) Pseudoparaphyses more or less, often very numerous, not distinctly cellular, threadlike, not easily gelatinizing, free above. As examples displaying this last type of pseudoparaphyses he cites *Hercospora*, *Rosellinia*, *Hypoxylon*, and *Xylaria*. He calls these pseudoparaphyses of his third type metaphyses.

In his first division he has a series of transitions from no paraphyses to paraphysoiden, to so-called genuine paraphyses. However, as he says, all of these are connected to the perithecial membrane above the asci. In his second type, the Diaportheen, all arise from the ascal layer, and are free above.

Guignardia Bidwellii (Ellis) Viala & Ravaz (PLATE 21, FIG. 4) represents Petrak's first type; also *Dothidea collecta* (Schw.) Ellis (TEXT FIGURE 2). The tissue above the asci is stroma in process of dissolution, and there are no paraphyses. The condition in *Chaetosphaeria phaeostroma* (Mont.) Sacc. (PLATE 21, FIGS. 2, 3) and also *Dibotryon morbosum* (Schw.) Th. & Syd. (PLATE 21, FIG. 6) corresponds to his second and third types. The strips of tissue are connected at the top and are plainly to be seen as only strips of dissolving pseudoparenchyma. *Hypoxylon Howeianum* Peck. (PLATE 22, FIG. 5) is of the Diaportheen type, and has what Petrak calls metaphyses.

It is evident that Petrak has not considered the origin of his so-called dothideaceous type of paraphyses. He says (21: 67) that pseudoparaphyses have free ends, while genuine paraphyses are grown above to the perithecial cover. The illustrations cited above show plainly that these strands are only stromal remnants. Moreover, no part of the stroma, which is external to the ascomogenous layer, could by any series of transitions become genuine paraphyses. In the Discomycetes true paraphyses are never found growing down from the top of the apothecium. There is no way that one can reconcile these stromal parts with paraphyses. Petrak is merely attempting here to show by means of the pseudoparenchymatous threads hanging from the top of the centrum that the Pseudosphaeriales grade into the Sphaeriales. The separation between paraphyses in the Sphaeriales and

stromal remnants in the Dothideales is just as exact as between the wall in one case and the stroma in the other.

True paraphyses, then, are sterile hyphae, which arise in the ascogenous layer, and have free ends converging towards the ostiolum. They appear before the asci, and usually gelatinize at maturity.

Comparison of Development of the Dothideales and the Sphaeriales

The illustrations of *Chaetosphaeria phaeostroma* (Mont.) Sacc. (PLATE 21, FIGS. 1, 2, 3) show a development typical of the Pseudosphaeriales of Theissen and Sydow (29). First a pseudoparenchymatous stroma develops; then an archicarp appears slightly below its center. As this grows the ascogenous hyphae and asci appear, and the latter grow upward in the pseudoparenchyma. This tissue appears to undergo a chemical dissolution as the asci increase in size. Its cell walls become thinner, and the black coloration in them dissolves. Apparently, this part of the stroma acts as nurse tissue in the same manner as do tapetal layers surrounding pollen grains in the Spermatophyta. The formation of the opening is accomplished by the same type of chemical dissolution. The dark-walled external cells directly above the developing archicarp become hyaline and thin-walled and gradually break apart. The actual break is probably caused by the expanding hymenial layer. With the low power of the microscope the canal appears as a typical ostiolum, but when examined with the high power it is seen to contain, instead of periphyses, merely cell fragments.

The method of development typical of the Dothideales is to be seen in the longitudinal section through the stroma of *Dothidea collecta* (TEXT FIGURE 2). The asci develop from a convex placenta, in the same manner as in *Mycosphaerella Fragariae* (Schw.) Lind., growing upward in the stroma, and at maturity the stroma disintegrates to form an irregular opening through which the spores escape. In *Guignardia Bidwellii* (PLATE 21, FIG. 4), the same type of development as that in *Dothidea collecta* is shown, except in that the ascogenous layer is flat instead of convex. In all cases the stroma develops first, and the archicarp

later. There is no indication of a perithecial wall, the centrum being solidly pseudoparenchymatous.

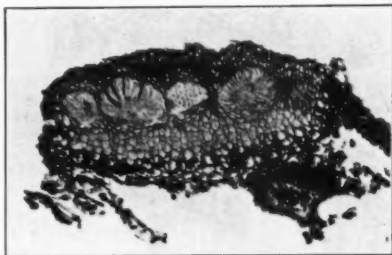


FIG. 2. *Dothidea collecta* (Schw.) Ellis & Ev. Longitudinal section through a mature stroma showing groups of asci in locules.

Blain (2: 17) says in regard to the Dothideales: "Nearly all of the fungi examined possessed a concentric layer of thin, hyaline compressed cells around the periphery of the locule, the lining." This is not comparable to a wall in any sense. It is due to the dissolution process, and to pressure from the growing asci, to which these cells are subjected.

This dothideaceous type of development is also seen in *Dibotryon morbosum* (PLATE 21, FIG. 6), and in *Leptosphaeria Doliolum* (Pers.) Wint. (PLATE 21, FIG. 5), the threads simulating paraphyses being stromal remnants as previously explained.

Nichols (20: 316) says in regard to the development of *Teichospora obducens* (Fries) Fuckel and *Teichospora sporadica* Atk.: "A single cell of the mycelium by successive divisions and growth forms a solid sphere of parenchymatous tissue. Certain of the interior cells of this tissue become enlarged and differentiated into asci." This is typical of dothideaceous development. The cell that initiates the stroma, in locular forms, cannot possibly be considered the archicarp. That organ arises later.

The type of development found in the Sphaeriales produces Petrak's "Diaporthen centrum." The archicarp always develops in a stroma, whether there be a single perithecium or many. The wall forms early, shutting out all of the stromal parenchyma.

In TEXT FIGURE 1, *Rosellinia aquila* (Fries) De-Not. is pictured to provide an example of a single perithecium enclosed in a stroma.

This form has not been considered as one of the stromatic Sphaeriales. The stromal part, which encloses the perithecium, has been thought of as a part of the perithecial wall. This, however, is ectostroma, under which the perithecium develops in the same manner as in *Hypoxylon*. The stroma is hard and carbonaceous, but the perithecial wall is not. The illustrations of perithecia of *Neurospora* by Shear and Dodge (27: Pl. 4, A, B, C) show typical perithecia, in which there is a definite wall, and also a thin pseudoparenchymatous layer on the outside, just as in species of *Rosellinia*. This pseudoparenchyma is stroma. Histologically it is the same as the stroma in such compound fructifications as in *Hypoxylon*. All the tissue that does not arise from the original coil is stroma. Apparently all the so-called nonstromatic forms in the Sphaeriales are in reality stromatic.

The development of *Hypoxylon Howeianum* Peck. is illustrated on PLATE 22. A coiled archicarp arises in the periphery of the entostroma (FIGS. 4 AND 7). By further growth this gives rise to a ball of hyphae. The outer hyphae of this knot are smaller in diameter than those on the inside. Next, the outer threads coalesce to form a globose wall. Inside of this wall are loosely coiled segments of large diameter, which later give rise to ascogenous hyphae. These have been called "Woronin hyphae." The wall definitely shuts out the stroma. The fertile segments gradually settle out, forming a peripheral layer lining the wall. At this stage the apical region of the wall begins to grow upward, cone-like. This gradually grows out through the ectostroma (FIG. 3) and forms the ostium in the manner described above under the explanation of ostium. The mature perithecial centrum is then surrounded by a wall (FIG. 5), the sides and base of which are lined with asci and paraphyses, and the ostiolar canal is lined with paraphyses. This fully equals Petrak's *Diaportheen* type of centrum as described previously.

This method of development corresponds closely with that of *Xylaria polymorpha* (Pers.) Grev., as described by De Bary (1: 216): "The primordia of the perithecia make their appearance in the form of small spherical bodies, which lie in the medulla close beneath the black rind, and are at once distinguished from the medullary tissue by containing no air and therefore being

transparent. They are formed of a closely woven mass of slender hyphae, which are much thinner than the hyphae of the original tissue and must therefore be a new formation in it. In somewhat older specimens an irregular large-celled coil of tissue is found lying in the middle of the sphere. The spheres now increase in size in the direction of the medulla, the shape, structure and position remaining the same. Then a dense tuft of straight hyphae, in the shape of a broad truncated cone, shoots forth from the part which abuts on the rind and elongates in the direction of the rind, which is first bulged out a little and then gradually pierced through, so that the extremities of the hyphae project above the surface. The young perithecium has meantime become egg-shaped, its broader portion lying in the medulla being the future basal part, while the narrow end which is wedged into the rind is the future neck with the ostiole."

Modern investigators have added to our knowledge of the early stages of development within the centrum.

Brown (3: 4) says of *Xylaria*, "Soon a definite perithecial wall is to be seen (FIG. 10). As this grows it seems to spread so as to make more space within; the Woronin hyphae appear to lie loosely within the space enclosed. . . . As the segments enlarge the ends tend to become rounded so that the connection between segments is very slight, and they finally separate completely. Each seems to be an independent structure. The hyphae during the stages figured in 10 and 11 seem to be loosely coiled in the large space in the center of the developing perithecium but a little later they come to lie near the perithecial wall. . . . Later some of them send out branches and these branches give rise to ascogenous hyphae (p. 5). Following the stage shown by FIGURES 23 AND 24, with the enlargement of the perithecium, there is an increased growth of threads from the inner portion of the perithecial wall. . . . They extend from the wall and gradually fill the space within. These ingrowing hyphae form the periphyses and paraphyses (p. 7)."

Lupo (17: 494), in regard to the development of *Hypoxylon coccineum* Bull., says: "The formation of the perithecium is initiated by the massing of the hyphae into a circular knot, within the center of which the Woronin hyphae differentiate."

Dawson (4: 255), in regard to the development of *Poronia punctata* Fries, says: "The mature perithecium consists of a very definite wall of closely interwoven hyphae lined with a smaller-celled hymenial layer, whence arise the very numerous club-shaped asci, intermingled with numerous paraphyses. The somewhat long neck which opens by an ostiole to the exterior, is lined by delicate paraphyses, which more or less completely fill the cavity leading into the perithecium."

The fundamental point of difference then between the Sphaeriales and the Dothideales is not the presence of pseudoparenchyma in the centrum in the latter, but the presence of the wall in the former, which determines that stromal tissue may not be enclosed in the centrum. If one could eliminate the stroma, it could be said in truth that in the Dothideales the ascal layer is gymnocarp from the beginning, and in the Sphaeriales angiocarp.

Discussion of the Pseudosphaeriales Question

Von Höhnelt, Theissen, and Sydow were the first mycologists to recognize that there are unilocular forms in the Sphaeriales with a different type of development from the remainder. Von Höhnelt (10, 11) founded the family Pseudosphaeriaceae on the genera *Wettsteinia* and *Pseudosphaeria*, and separated it as follows: stromata small, sunken, perithecium-like, with several locules standing near one another, each of which contains a single ascus. Theissen and Sydow (29) raised this family to ordinal rank. They say this order is recognized for sphaeriaceous fungi whose asci are separated by thin pseudoparenchymatous strands; and each ascus cavity is accordingly demonstrated to be a "monasker Lokulus," and the entire visible conceptacle as a stroma with many locules. They found many forms in the Sphaeriales that had this pseudosphaeriaceous centrum. The condition was considered to be related to that in *Myriangium* and *Plectodiscella*, where each ascus rests in its own locule. Also the Dothideales, *sensu strictu*, were seen to have this type of centrum. These writers, therefore, created the group Dothidiineae to comprise the three orders, 1. Myriangiales, 2. Dothideales, and 3. Pseudosphaeriales. They (29: 5) say that these orders are united by the common basic character of one-ascal locules. The last two orders

were separated as being stromatic (Compositae) and simple (simplices), respectively. In the Pseudosphaeriales they placed the following families: Epipolaeaceae, Parodiellaceae, Pleosporaceae, Cucurbitariaceae, Botryosphaeriaceae, Pseudosphaeriaceae, and the Sphaerellaceae.

Von Höhnelt (11: 634) considered the Pseudosphaeriaceae as being a connecting link between the Sphaeriales and the Dothideales, but says they remind one of the Myrangiaceae, due to the fact that the locules contain single asci.

Petrak (21) made a comparative study of a great many forms that von Höhnelt or Theissen and Sydow had placed in the Pseudosphaeriaceae von Höhnelt (or Pseudosphaeriales Th. & Syd.), and says that neither von Höhnelt nor Theissen and Sydow grasped their true meaning. After studying the species in the genera of the family Pleosporaceae, he says (21: 48) that with the species of the genera *Pleospora*, *Pyrenophora*, and *Leptosphaeria* the development of the perithecium of the typical Sphaeriales from a dothideaceous stroma can be followed very beautifully. The gradual formation of the ostium goes hand in hand with the changing of the stromatically formed wall into a perithecial membrane typical of the Sphaeriales, and with the increase in the number of asci there follows the development of typical paraphyses from the pseudoparenchymatous centrum tissue of the dothideaceous stroma. Further (21: 64), he says that von Höhnelt's Pseudosphaeriaceae are nothing but the primitive forms from which the Sphaeriales have developed, and that they bind the Sphaeriales directly with the Dothideales.

He brings this transition about through four developmental stages as follows:

1. Ostium still to be considered as a small, papillate extrusion of the conceptacle. Conceptacle wall very thickly pseudoparenchymatous, of rather homogeneous structure, differentiated into a dark colored outside crust, and a hyaline pseudoparenchymatous ground tissue. Asci not numerous, but very thick. Ground tissue still at maturity very plainly pseudoparenchymatous. . . . *Weltsteinia*, *Pseudosphaeria*.

2. Ostium distinct, however atypically developed; that is, remaining closed, but at maturity breaking out more or less.

Perithecial membrane strongly differentiated. Asci somewhat numerous, elongate, or thick clavate. Centrum tissue at maturity more or less threadlike, not plainly cellular.... *Pyrenophora phaeocomes*, *P. trichostoma* and *Pleospora herbarum*.

3. Ostiolum entirely typical; that is, at first completely closed, opening late, through partial gelatinous absorption of its tissue. Conceptacle wall still rather thick, more or less plainly differentiated in two layers. Asci numerous, slender. Ground tissue in the mature condition scarcely to be distinguished from typical paraphyses.... *Leptosphaeria Doliolum*.

4. Ostiolum typical, opening through a more or less round pore. Perithecial membrane composed of from a few to numerous layers of bright colored to dark colored, more or less compressed cells, membranaceous, leathery, or carbonaceous, never sclerotial. Asci very numerous, slender, centrum tissue composed of typical, more or less branched, robust, usually numerous paraphyses.

It is impossible for the gap between the Dothideales and the Sphaeriales to be bridged over in this manner. The fact that forms can be found with consecutively thinner walls does not mean that a membrane which is histologically stroma can ever be a true wall, nor can an ostiolum in the sense of Petrak by any series of transformations ever become a genuine ostiolum. The latter could exist only in the apex of a wall formed from the archicarp in the manner previously described in this paper for *Hypoxylon Howeianum*. Interthecial tissue (stromal remnants) is found in all of Petrak's pseudosphaeriaceous fungi, and that very fact shows that there is no continuous wall as in the Sphaeriales. Any species which lacks a true wall necessarily has stromal tissue above the ascial layer, and so definitely belongs in the Dothideales.

Von Höhnelt considered that a fruit-body with a thin wall and an apical papillum constituted a genuine perithecium. He separated the genus *Leptosphaeria*, all of whose species have the dothideaceous type of centrum, into three genera. He (14: 135) first divided the genus into a dothideaceous *Leptosphaeria* Ces. & De-Not, based on the type, and a sphaeriaceous *Leptosphaeria*, which he put in *Nodulosphaeria* Rab. Later (15: 158), he distinguished a pseudosphaeriaceous *Leptosphaeria*, which he named

Scleropleela. He also failed to take into consideration the primary separation between the Dothideales and the Sphaeriales; i.e. the wall character.

It is now evident that von Höhnelt, Theissen and Sydow, and Petrak, while recognizing in part the characters of the unilocular forms, fail to agree on the limits of the Pseudosphaeriales, on the species and genera they include in the group, and in their conception of the morphology and homology of certain characters, e.g. wall, ostium, and paraphyses, which are of fundamental importance. Neither the taxonomic position of these forms nor their morphologic characters have been satisfactorily treated by any of these investigators. The unsatisfactory character of their work on the Pseudosphaeriales has been due to their failing to distinguish between pendant strips of partially dissolved stromatic pseudoparenchyma, and to their confusing the perithecial wall with the stroma.

It is impossible to make these forms transitions between the Dothideales and the Sphaeriales. None of them have a true wall, nor true paraphyses, and all have stromal parenchyma in the centrum. All of the characters found in the Pseudosphaeriales are common to members of the Dothideales. Therefore, they should be placed in the Dothideales, and it would seem that their position there should be determined by characters found in the centrum, such as characters of the ascus and ascospore and characters of the ascal hymenium. Such characters as the thickness or thinness of the stromatic wall or of the number of locules in the stroma apparently have no value.

The Relationship of the Myriangiales to the Dothideales and Pseudosphaeriales

According to Theissen and Sydow (29) the Myriangiales, Dothideales and Pseudosphaeriales are united by the common, basic character of the uniascal locule. Petrak (21: 61) points out that this is true in a strict sense for *Myriangium*, but not for members of the other two orders. However, he derives the latter from simple Myriangiales by increasing the number of asci from one to many, increasing the ascal plectenchyma in a horizontal direction in the stroma, and decreasing the thickness

of the outer stromal layer. Next he has the ascogenous plectenchyma increase in a manner to bring forth numerous asci, the outside crust becomes the perithecial membrane, and the papillate primitive condition changes into an ostiolum, the centrum pseudoparenchyma develops into paraphyses, and he has developed a genuine perithecium.

Gäumann (7: 209) would also derive the Pseudosphaeriales from the Myriangiales, and in fact makes the order Myriangiales comprise the families Myriangiaceae, Saccardiaceae, Dothioraceae, and Pseudosphaeriaceae. He thinks the genus *Kusanoopsis* represents the most primitive form. It forms dark cushions on leaves. The stroma is composed of homogeneous pseudoparenchyma, with no special rind. The asci are scattered in several layers over the entire interior of the stroma, with the exception of a sterile foot which projects into the mesophyll. The asci are spherical, and in individual locules. His second family differs from the Myriangiaceae only that its asci are no longer regularly formed in several layers, but are arranged in a single layer, which usually lies directly under the surface of the stroma and parallel with it. He says that they are not well known, but if one places the asci of *Kusanoopsis* in a single layer one can acquire an idea of their form. One might as fairly say, if he placed the asci of *Myriangium* in one group in the stroma he would have *Guignardia*, *Dothidea* or any other dothideaceous form. The jump between *Kusanoopsis* and the Dothideales, where the asci arise in a single layer, is far too great to warrant the placing of the Dothideales in the Myriangiales.

In TEXT FIGURE 3, a longitudinal section through the stroma of *Myriangium Duriaei* Mont. is shown. The asci are distinct with definite pseudoparenchyma separating them. The writer sectioned material of various ages and could find no indication that the asci arise from a common archicarp. It certainly appears as though each ascus arises from its own archicarp, and that these initials arise at irregular intervals in the stroma. In this case then the asci are truly unilocular. In PLATE 21, FIG. 5, *Leptosphaeria Doliolum* (Pers.) Wint. is illustrated. Here the asci arise from a common hymenium and grow up into the pseudoparenchyma of the stroma. As they elongate, the cells

separate into thin strands which hang down between the asci at maturity. The writer has sectioned material of *Pleospora herbarum* (Pers.) Rabh. and finds the situation not at all comparable to Gäumann's figure (7: FIG. 145) of this fungus. In his

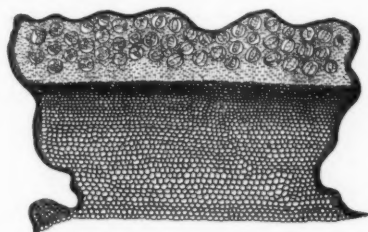


FIG. 3. *Myriangium Duriaei* Mont. Longitudinal section through an ascigerous portion of the stroma, showing single asci in stromal locules.

drawing the pseudoparenchymatous strands of interthecial tissue are shown connected at the top and bottom of the locule, apparently putting each ascus in a single pocket. The writer finds the ascus hymenium to be continuous at the base as in *Leptosphaeria Doliolum*. It is impossible to homologize each ascus and its interthecial tissue here with the unilocular condition in *Myriangium*. The whole centrum in *Leptosphaeria* and *Pleospora* has a common origin, and is therefore homologous with the single ascus pocket of *Myriangium*. If the single archicarp in *Myriangium* could be conceived as continuing its growth and developing a horizontal layer in the stroma from which numerous asci then arose, and should thus evolve a dothideaceous type, then with equal logic it would be possible to think of the locule of *Myriangium* as having been derived by reduction from a typical dothideaceous locule containing many asci. An outer covering which is clearly stromatic cannot give rise by evolution to such a wall and ostiolum as that found in the Sphaeriales.

Gäumann (7: 209) places most of Theissen's Pseudosphaeriales in the families of the Myriangiales, but says that they are transition forms to the Sphaeriales through a series with gradually decreasing stroma and more apparent ostiola and with increasing gelatinization of the interthecial tissue. In this regard he agrees with Petrak as stated previously. Further (7: 219), he says that

Leptosphaeria Doliolum and *Leptosphaeria acuta* (Moug. & Nestl.) Wint. represent the beginning and end points of a series which leads from the genuine Pseudosphaeriales to the genuine Sphaeriales. Then further on (7: 255), he says that the Sphaeriales were erected as a parallel line to the Hypocreales from which they differ through their dark colored, leathery, hard, or carbonaceous perithecia, but recent examinations have shown him that this holds for only a part of the order, while another part of the developmental series is an off-shoot from the Hypocreales. From this he thinks that the Sphaeriales as at present grouped have no right to exist. Then he enumerates the Diaportheen type and the Pseudosphaeriales type as the two types in the Sphaeriales. In other words, he admits that if the fungi of the Pseudosphaeriales type were taken out, then the Sphaeriales would be of one type, and the centrum would then correspond to that found in the Hypocreales.

The mistakes made by the above investigators in the treatment of the Myriangiales were due to a lack of knowledge of the origin of the essential structures in the locule and in the perithecium. The Myriangiales may have arisen, as pointed out, by the reduction of the number of the asci in the locule to one, or these uniascal locular forms may represent the primitive ancestral types of all forms in which the ascal plectenchyma develops in a stroma and is not surrounded by a special wall, such as found in the Phacidiales, Hysteriales, Hemisphaeriales, Perisporiales, Coryneliaceae, Dothideales and Pseudosphaeriales.

Ordinal Separations in the Pyrenomycetes

In the Pyrenomycetes, the Hypocreales, Sphaeriales, Laboulbeniales, and the Erysiphaceae contain asci in true perithecia. The first two groups are closely related. Both have the Diaportheen type of centrum, true perithecial walls and ostiola. The separation of these two orders in the first place was due to a misconception of the "wall" in the so-called Sphaeriales. The black, carbonaceous "wall" in the Sphaeriales is in reality the stroma. In all the members of the Sphaeriales the true wall is thin, membranaceous, and quite variable in color. Moreover, the stroma is always fleshy when young, becoming woody, leathery,

or carbonaceous when old. Whenever a fungus of the type of *Rosellinia* is found with a relatively thin stromatic layer on the outside of the wall, it is impossible in the present system of classification to know whether to place it in *Rosellinia*, *Sordaria*, or *Melanospora*. In the texture of the stroma *Balansia*, *Myriogenospora*, *Ophiodothis*, *Hypocrella* and *Claviceps*, all in the Hypocreales, exhibit a series that definitely connect the Hypocreales with the Sphaeriales. All have the same type of ascus and ascospore, all have true perithecial wall, but the texture of the stroma varies from hard and carbonaceous to fleshy, and from black on the outside to colored. In view of these facts it seems that the color and texture of the stroma and perithecial walls are of doubtful value in separating these two orders. Therefore, it is suggested that the two be merged as one order characterized by the possession of a true perithecial wall and ostiolum.

The Erysiphaceae have a true perithecial wall, but the lack of an ostiolum should be sufficient to place them in a distinct order.

The membrane in the Laboulbeniales is apparently a true perithecial wall, but the lack of a well-developed mycelium is sufficient to maintain them in a distinct order.

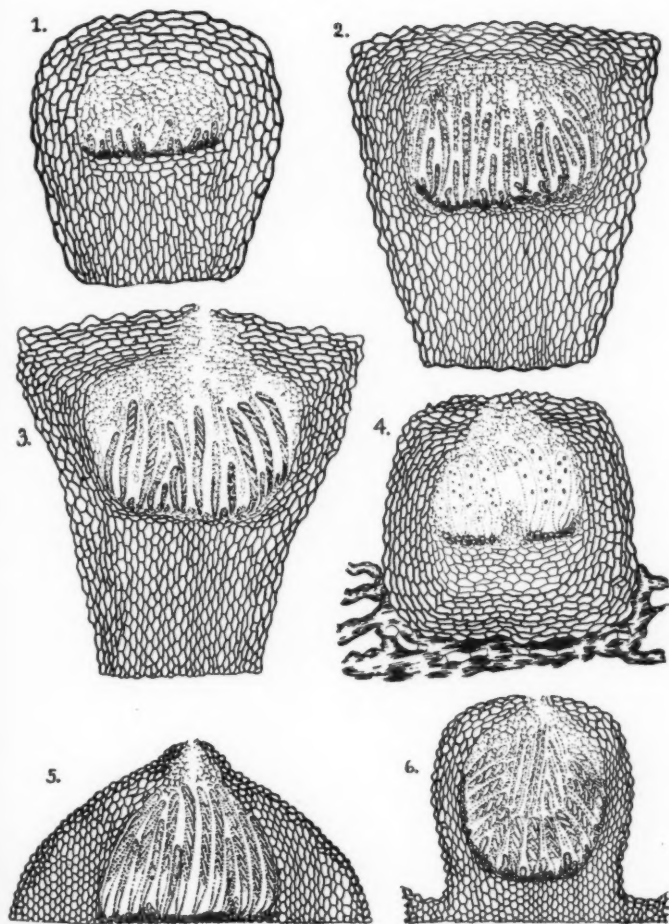
The Myriangiales, Pseudosphaeriales, Perisporiaceae, Coryneliaceae, and Dothideales all belong in one group distinguished by the absence of a true perithecial wall and by the asci being borne in locules in the stroma. They cannot be said to have a perithecium and are, therefore, not Pyrenomycetes.

The Erysiphaceae, Hypocreales, Sphaeriales and Laboulbeniales are sharply separated from the above group by the asci being borne in perithecia, and so are true Pyrenomycetes.

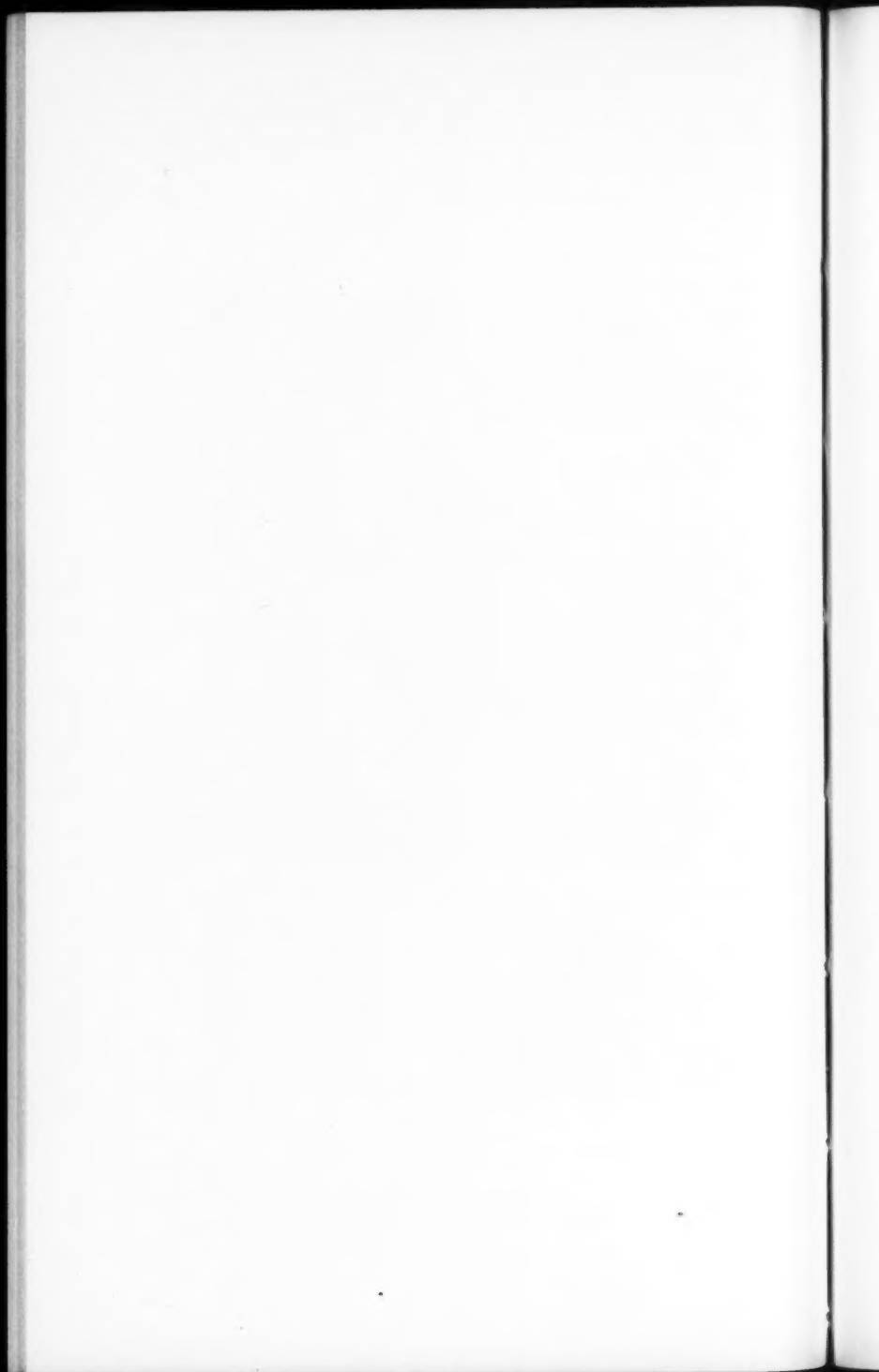
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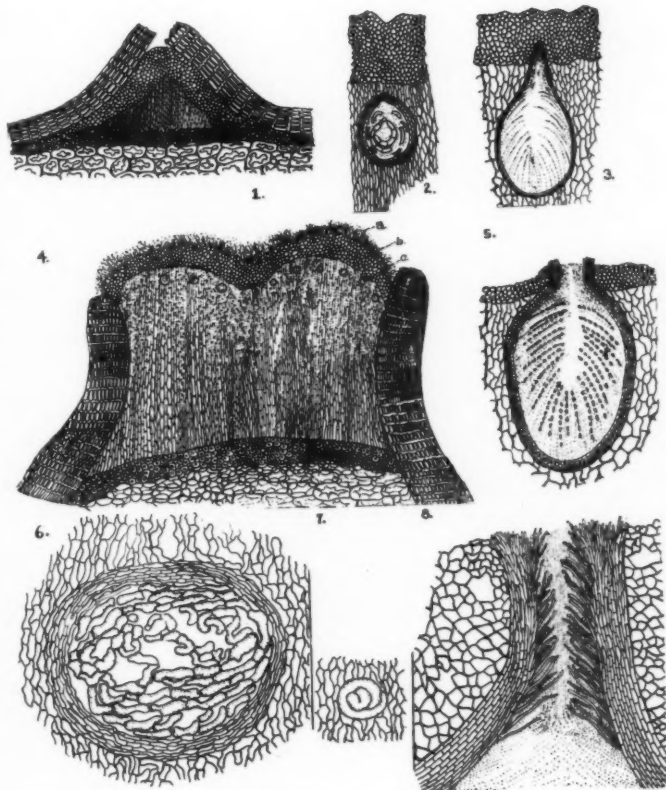
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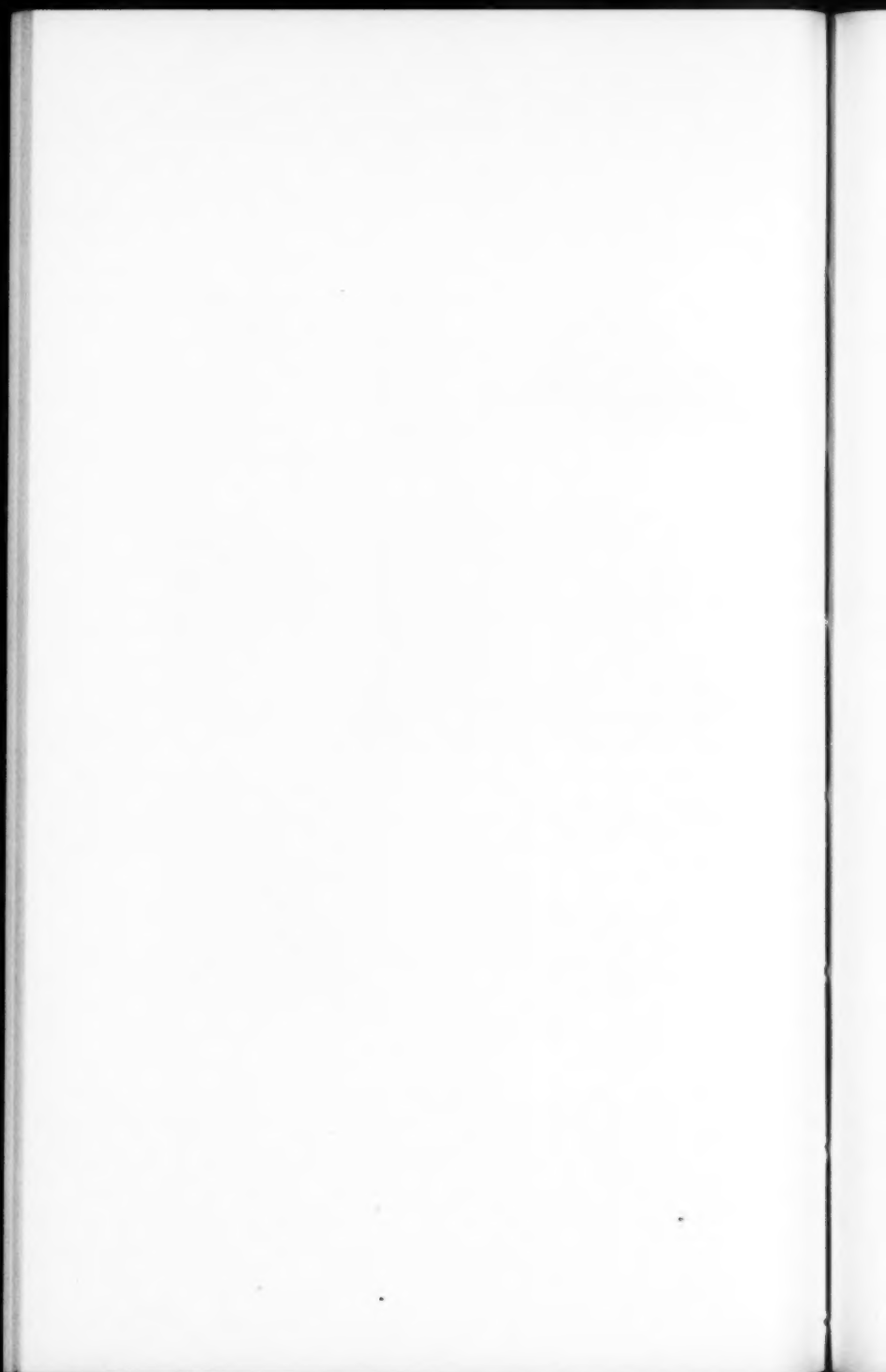


SPHAERIALES





SPHAERIALES



EXPLANATION OF PLATE 21

Fig. 1. *Chaetosphaeria phaeostroma*. Longitudinal section through young stroma showing immature asci growing upward in the pseudoparenchyma.

Fig. 2. *Chaetosphaeria phaeostroma*. Longitudinal section of a more advanced stroma. The pseudoparenchymatous strands are seen to be connected to the upper part of the stroma.

Fig. 3. *Chaetosphaeria phaeostroma*. Longitudinal section through a mature stroma showing the dissolution of the pseudoparenchyma to form an opening.

Fig. 4. *Guignardia Bidwellii*. Longitudinal section through a stroma showing its dothideaceous character.

Fig. 5. *Lepidosphaeria Doliolum*. Longitudinal section through mature stroma.

Fig. 6. *Dibotryon morbosum*. Longitudinal section through a mature locule. The paraphyses-like threads here are seen to be stromal remnants.

EXPLANATION OF PLATE 22

Development of *Hypoxylon Howeianum* Peck

Fig. 1. Longitudinal section through initial stroma showing the ruptured bark and the ectostroma being pushed upward by the developing entostroma.

Fig. 2. Longitudinal section through a very young perithecium showing the beginning of apical growth of the wall to form the ostiolar canal.

Fig. 3. Longitudinal section through a young perithecium showing the manner in which the perithecial neck penetrates through the ectostroma.

Fig. 4. Longitudinal section through the entire stroma. *a.* conidial layer. *b.* ectostroma. *c.* perithecial initials in the periphery of the entostroma.

Fig. 5. Longitudinal section through a mature perithecium.

Fig. 6. An enlarged view of a longitudinal section of a young perithecium. The entire wall completely shuts out the pseudoparenchyma of the stroma, and encloses only Woronin segments.

Fig. 7. Longitudinal section through an archicarp from which the perithecium, including its content, arises.

Fig. 8. Longitudinal section through the perithecial neck showing periphyses lining the ostiolar canal.

STUDIES IN TROPICAL ASCOMYCETES—V. SPECIES OF PHYLLACHORA

FRED J. SEAVER

(WITH PLATES 23-28)

The genus *Phyllachora* includes a group of parasitic Ascomycetes familiar to the mycologist in the northern regions mainly on grasses and sedges. In connection with our work in tropical islands, the writer has been impressed by the number of species of *Phyllachora* (using the name in a broad sense) which occur there on dicotyledonous hosts. Some of them appear to be undescribed while a number of species from the West Indies have been recently described by F. L. Stevens, C. E. Chardon, and other mycologists who have worked in the islands. Many, however, are very poorly known and an attempt is being made at this time to bring these together and publish them with brief diagnoses and illustrations.

In illustrating the species we have tried to do this in such a way as to show the character of the leaf-spots and at the same time give some idea of the size and form of the spores. In order to accomplish these results the leaves themselves have been properly mounted and the drawings of the spores made to accompany them. These combinations have been photographed together and the results reproduced in the accompanying plates. The drawings of the spores are made with the aid of the camera lucida but some allowance should be made for the sizes indicated in view of the fact that it is difficult to be sure that the spores are mature. This fact probably accounts for some of the discrepancies in the spore measurements as given by different authors.

The present paper includes only a part of the species reported from tropical America and it is expected that a later paper may follow with similar arrangement.

PHYLLACHORA ACACIAE P. Henn. Hedwigia 33: 233. 1894.

Phyllachora texana Tharp., Mycologia 9: 118. 1917.

Stromata gregarious and quite evenly scattered over the leaflets, varying in size from minute punctiform dots to more than 1 mm. in diameter, visible on both sides of the leaflets, occasionally several confluent, black and shining, the surrounding tissues reddish-brown; loculi few (usually only one or two) to each stroma, opening on the under side of the leaflet or on both; asci about $50-80 \times 10-14 \mu$, 8-spored; spores 1-seriate or irregularly crowded, ellipsoid or subfusoid, $4-5 \times 12-18 \mu$; paraphyses present delicate. (PLATE 27, F. 4.)

On *Acacia acutifera* Benth., Bahama.

Acacia amentacea DC., Mexico.

Acacia coriophylla Benth., Bahama.

Acacia uni-juga Rose, Mexico.

Acacia Wrightii Benth., Texas.

Vachellia Farnesiana (L.) W. & A., Porto Rico, Cuba.

TYPE LOCALITY: Ecuador on *Acacia Farnesiana*.

DISTRIBUTION: Texas to Florida and West Indies; also in South America.

***Phyllachora amyridicola* sp. nov.**

Stromata scattered or more or less aggregate on the upper side of the leaf but also visible on the under surface, very small, not exceeding .5 mm. in diameter, prominent on the upper side of the leaf; loculi few to each stroma, the necks of the ostiola prominent; asci clavate, 8-spored; spores irregularly disposed in the ascus, fusiform, $8 \times 20-25 \mu$. (PLATE 24, F. 2.)

Type collected on *Amyris Plumieri* DC., Jamaica, Sept. 18, 1907. (Britton 1507.)

DISTRIBUTION: Known only from the type locality.

***Phyllachora Amyridis* sp. nov.**

Stromata few, scattered over the upper surface of the leaf. Faintly visible on the under surface also, circular in form, convex, on the upper surface slightly rough, shining, reaching a diameter of 1 mm.; loculi numerous, closely crowded, the necks of the ostiola roughening the surface of the stroma; asci clavate, 8-spored, the spores 1-seriate or irregularly disposed, broad-ellipsoid, often slightly constricted in the center, $6 \times 14 \mu$. (PLATE 24, F. 1.)

Type collected on *Amyris elemifera* L. in Desecheo Island, Porto Rico, Feb. 18-19, 1914. (Britton, Cowell and Hess 1633.)

On *Amyris balsamifera* L., Cuba.

Amyris elemifera L., Florida.

DISTRIBUTION: Porto Rico, Cuba; also in Florida.

PHYLLACHORA ATELEIAE Seaver in Britton & Millsp., The Bahama Flora 632. 1920.

Stromata numerous, appearing on either side of the leaf but more conspicuous on the upper side, black, shining, scarcely exceeding a diameter of 1 mm., perithecia few to each stroma, conspicuous; asci clavate, reaching a diameter of 14-16 μ ; spores fusoid, hyaline, 4-5 \times 18-20 μ . (PLATE 24, F. 4.)

On *Ateleia cubensis* Griseb., Andros, New Providence, Great Exuma, Cuba.

TYPE LOCALITY: Andros, West Indies.

DISTRIBUTION: Andros and Cuba.

PHYLLACHORA BOURRERIAE Stevens & Dalbey, Bot. Gaz. 68: 54. 1919.

Stromata circular and black, abundant, scattered irregularly over the leaf, 1-2 mm. in diameter, equally prominent above and below, occupying the mesophyll; loculi several, globular, about 160 μ in diameter with a definite wall; asci cylindrical, 8-spored, 85 \times 9-12 μ ; spores fusiform, 6-7 \times 12-16 μ . (PLATE 20, F. 2.)

On *Bourreria succulenta* Jacq., Porto Rico.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico.

ILLUSTRATIONS: Bot. Gaz. 68: pl. 6, f. 3-4.

Phyllachora Brittoniana (Chardon) comb. nov.

Catacauma Brittoniana Chardon, Mycologia 19: 298. 1927.

Spots large, yellowish, 10 to 15 mm. in diameter, very conspicuous on the under surface of the leaf, scarcely so on the upper surface, possessing many confluent stromata; stromata black, not shiny, 2-5 mm. in diameter or even more through the coalescence of various individuals, largely raised and very pronounced on the under surface, sometimes, but not always, following the veins of the leaf, distinctly situated between the epidermis and the mesophyll; loculi several, 2-7 in each stroma, flattened, or angular through lateral pressure; asci cylindrical-

clavate, 8-spored; spores navicular, 1-seriate above, 2-seriate in the main body of the ascus, continuous, hyaline, $4-5 \times 15-18 \mu$, possessing one or several oil drops; paraphyses present, profuse. (PLATE 25, F. 6.)

On *Ficus subscabrida* Warb.

TYPE LOCALITY: Isle of Pines.

DISTRIBUTION: Known only from the type locality.

ILLUSTRATIONS: *Mycologia* 19: pl. 27, f. 1.

A fine collection of this species was made by Dr. and Mrs. Britton and Mr. Percy Wilson on the Isle of Pines in 1916, No. 15472. Several years ago the writer undertook the task of illustrating the species *Phyllachora* of the tropics and this was included as an undescribed species. In the meantime, Mr. Chardon described the species and illustrated it as indicated above. It is quite fitting that it should have been dedicated to Dr. N. L. Britton who originally collected the fungus.

PHYLLACHORA CANAFISTULAE Stevens & Dalbey, Bot. Gaz. 68: 55. 1919.

Stromata thickly and rather evenly scattered over the leaf, visible on either side but more conspicuous on the upper, convex and roughened by the protruding necks of the ostiola, shining or with a dull gloss, reaching a diameter of 2-5 mm., irregularly rounded; loculi numerous, opening on the upper surface of the leaf; asci clavate, 8-spored; spores partially 7-seriate, ellipsoid but usually attenuated below, $6-8 \times 13-16 \mu$. (PLATE 26, F. 3.)

On *Cassia Fistula* L.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico.

ILLUSTRATIONS: Bot. Gaz. 68: pl. 6, f. 5-6.

Phyllachora conspicua (Chardon) Seaver, comb. nov.

Trabutia conspicua Chardon, *Mycologia* 19: 296. 1927.

Stromata thickly scattered over the surface of the leaf but visible on the upper side only, forming irregular patches 1 cm. or more in diameter radiating from a central point in zigzag irregular branching lines about 1 mm. in diameter, smooth and shining; loculi numerous and slightly conspicuous; asci clavate, 8-spored; spores narrow-ellipsoid, $6-7 \times 20-24 \mu$. (PLATE 26, F. 2.)

On *Capparis Grisebachii* Eichl.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico; Cuba.

ILLUSTRATIONS: Mycologia 19: pl. 27, f. 4.

PHYLLACHORA DRYPETICOLA Stevens & Dalbey, Bot. Gaz. 68: 55. 1919.

Stromata scattered over part of the leaf, equally visible on either side, dull, about 1-2 mm. in diameter; loculi several to each stroma, the necks of the ostiola strongly protruding; asci cylindrical to clavate, 8-spored; spores large, fusoid, 1-seriate to 2-seriate, $4-7 \times 17-22 \mu$. (PLATE 27, F. 1, 5.)

On *Drypetes glauca* Vahl., Porto Rico.

Drypetes lateriflora (Sw.) Krug & Urban, Florida, Jamaica.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico, Jamaica; also in Florida.

PHYLLACHORA ENGLERI Speg. Anal. Soc. Ci. Argent. 19: 96. 1885.

Phyllachora Philodendronis Pat. Bull. Soc. Myc. Fr. 8: 134. 1892.

Spots indeterminate, only slightly pale or not at all; stromata densely gregarious, slightly lenticular, visible on both sides of the leaf, reaching a diameter of 3-5 mm., circular or subcircular in form, smooth and shining, black; loculi immersed, closely crowded, lenticular-conoid, small, $120-140 \mu$ in diameter with the ostiola minute, reaching a diameter of $120-140 \mu$; asci cylindric, truncate above, attenuated below, 8-spored; spores 2-seriate, ellipsoid or ellipsoid-navicular, attenuate at both ends, straight or curved, containing two large oil drops, $4-5 \times 14 \mu$. (PLATE 23, F. 1.)

On *Philodendron* sp., Ecuador, Guatemala.

Anthurium acaule Schott, Bolivia.

Anthurium dominicense Schott, Porto Rico.

Anthurium Holtonianum Schott, Colombia.

Anthurium isertianum Schott, Martinique.

Anthurium panduratum Mart., Brazil.

Anthurium scandens (Aubl.) Engler, Jamaica, Porto Rico, Bolivia.

Anthurium venosum Griseb., Cuba.

TYPE LOCALITY: Paraguay, on *Spathicarpa lanceolata* Engler.

DISTRIBUTION: West Indies; also in Northern South America.

PHYLLACHORA FUSICARPA Seaver in Britton & Millsp. The Bahama Flora 633. 1920.

Stromata rather numerous, often thickly scattered over the leaf, visible on both sides but more conspicuous on the under side, small, ranging from 1-2 mm., several often confluent; perithecial cavities few to each stroma, opening on the under side of the leaf; asci clavate, 8-spored; spores fusiform or approaching fusiform, slightly unsymmetrical, about $6 \times 25-30 \mu$. (PLATE 23, F. 3.)

On *Duranta repens* L., Bahama, Porto Rico.

TYPE LOCALITY: New Providence.

DISTRIBUTION: Porto Rico, Bahama.

PHYLLACHORA GRATISSIMA Rehm, Hedwigia 31: 306. 1892.

Stromata epiphyllous, for the most part occurring on yellowish spots which reach nearly 1 cm. in diameter, usually several stromata on each spot, the stroma convex, rough, black, shining, usually 1-2 mm. in diameter but often several confluent, visible on the under side of the leaf, yellowish spots; perithecia immersed, the ostiola rather prominent, comparatively few to each stroma; asci clavate, about $20 \times 100-110 \mu$, 8-spored; spores very large, ellipsoid, unequal sided, granular within, hyaline or slightly yellowish, $12-14 \times 20-25 \mu$. (PLATE 24, F. 3.)

On Lauraceae.

Persea Persea (L.) Cockerell (*Persea gratissima* L.), Porto Rico, Jamaica.

TYPE LOCALITY: Ecuador.

DISTRIBUTION: West Indies; also in South America.

EXSICCATI: Rehm, Ascom. 1974.

PHYLLACHORA INCLUSA (Berk. & Curt.) Sacc. Syll. Fung. 3: 599. 1883.

Dothidea inclusa Berk. & Curt. Proc. Am. Acad. Arts & Sci. 4: 129. 1860.

Stromata thickly scattered over the surface of the leaf, often about equally visible on either side, fairly prominent, small, not exceeding .5 mm. in diameter, subcircular in form, surface minutely roughened, dull; loculi one or few to each stroma, not conspicuous; asci clavate, 8-spored; spores fusoid, $10 \times 15-20 \mu$. (PLATE 28, F. 5, type.)

On *Jacquinia Berterii* Spreng., Porto Rico.

TYPE LOCALITY: Nicaragua, on *Jacquinia* sp.

DISTRIBUTION: Porto Rico; also in Nicaragua.

In the type collection on a thin-leaved unnamed species of *Jacquinia* the stromata are about equally visible on either side of the leaf, while in the Porto Rican specimen on a thick-leaved species of *Jacquinia* they are scarcely visible on the under side.

PHYLLACHORA LATHYRI (Lév.) Theiss. & Syd. Ann. Myc. 13: 501. 1915.

Dothidea Lathyri Lév. Demidoff Voyage 2: 106. 1915.

?*Mazzantia fennica* Lind, Ann. Myc. 13: 22. 1915.

Stromata numerous and scattered over the upper surface of the leaf but visible on the under surface as well, either subcircular or irregular in form, convex, on the upper side uneven and dull, reaching a diameter of 1 mm.; loculi numerous, rather close together; asci cylindrical or clavate, 8-spored; spores 1-seriate, narrow-ellipsoid, more narrowed at the lower end, $6-8 \times 13-17 \mu$. (PLATE 23, F. 5.)

On *Bradburya virginiana* (L.) Kuntze.

Galactia sp.

TYPE LOCALITY:

DISTRIBUTION: Porto Rico; also in Europe and Asiatic Russia.

PHYLLACHORA MAYEPEAE Stevens & Dalbey, Bot. Gaz. 58: 56. 1919.

Spots irregularly circular, indefinite without border, tan or yellow, shading to normal green, 3-15 mm. in diameter, bearing numerous (5-50) circular, black, punctiform stromata which are visible above and below, about 1 mm. in diameter, occupying the mesophyll, each stroma containing one perithecial cavity; asci $18-27 \times 58-85 \mu$, 8-spored; spores $7-8 \times 18-20 \mu$, hyaline. (PLATE 27, F. 2.)

On *Mayepea domingensis* (Lam.) Krug & Urban.

TYPE LOCALITY: Maricao, Porto Rico.

DISTRIBUTION: Porto Rico.

PHYLLACHORA MYRCIAE (Lév.) Sacc. Syll. Fung. 2: 597. 1883.

Dothidea Myrciae Lév. Ann. Sci. Nat. III. 5: 264. 1846.

Catacauma Myrciae Theiss. & Syd. Ann. Myc. 13: 393. 1915.

Stromata gregarious, one to a dozen on each leaf, occurring on

the under side of the leaf and not visible on the upper side, circular or subcircular in form, reaching a diameter of 2-3 mm., smooth, shining; perithecial cavities disposed in a circle around a central point, more or less confluent; asci broad, clavate, $20 \times 60-75 \mu$, 8-spored; spores acute at either end, strongly curved so as to appear half-moon shaped, measuring $18-20 \mu$ from horn to horn, with a thickness of 8μ , occasionally nearly straight (apparently when young). (PLATE 23, F. 4.)

On *Myrcia paniculata* (Jacq.) Krug & Urban, Porto Rico, Virgin Islands.

TYPE LOCALITY: Brazil, on *Myrcia* sp.

DISTRIBUTION: Porto Rico, Virgin Islands; also in South America.

Theissen and Sydow who have examined the original specimen of this species state "Asken und Sporen waren nicht mehr vorhanden." The spores were described as subarcuate, while the spores in our specimen are more than subarcuate. They are decidedly lunulate. The specimen however doubtless belongs here.

PHYLLACHORA NECTANDRAE Stevens & Dalbey, Bot. Gaz. 68: 57. 1919.

Stromata situated on brown spots on the upper side of the leaf, but visible on the under side, scattered or more rarely confluent, black, shining, reaching a diameter of 1-4 mm.; loculi single or few to each stroma; asci cylindrical or clavate, 8-spored; spores ellipsoid, $5 \times 14 \mu$. (PLATE 28, F. 2.)

On *Nectandra patens* (Sw.) Griseb.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico.

PHYLLACHORA NITENS Garman, Mycologia 7: 339. 1915.

Stroma forming a large, black, shining spot often covering an area of several cm., appearing on both sides of the leaf; perithecial cavities numerous but not prominent; asci clavate, 8-spored, $12-16 \times 100-110 \mu$; spores ovoid, acute at one end, $8 \times 12 \mu$, often with an appendage $6-8 \mu$ long. (PLATE 27, F. 4.)

On *Schlegelia brachyantha* Griseb., Porto Rico.

Schlegelia axillaris Griseb., Dominica.

TYPE LOCALITY: Maricao, Porto Rico, on *Schlegelia brachiata*.

DISTRIBUTION: Porto Rico.

PHYLLACHORA OCOTEICOLA Stevens & Dalbey, Bot. Gaz. **68**: 57. 1919.

Stromata sparingly scattered over the leaf, about equally visible on either side, not prominent on either, irregularly rounded, subshining, reaching a diameter of 2-4 mm; loculi several to each stroma, not very prominent; asci cylindrical to clavate, 8-spored; spores partially 2-seriate, ellipsoid, or fusoid, $7-8 \times 17-20 \mu$. (PLATE 27, F. 3; PLATE 28, F. 3.)

On *Ocotea leucoxylon* (Sw.) Mez.

TYPE LOCALITY: Porto Rico.

DISTRIBUTION: Porto Rico.

Phyllachora Pennellii sp. nov.

Stromata distributed over the surface of the leaf and about equally visible on either side, forming beautiful patterns on the substratum like Chinese writing or hieroglyphics, elongated and radiately branched, the branches reaching a length of 1-2 cm. and a diameter of 1-2 mm., dull; loculi numerous and roughening the surface of the stroma; asci clavate, 8-spored; spores ellipsoid, 1-seriate or 2-seriate, about $6-7 \times 12-14 \mu$, slightly yellowish. (PLATE 26, F. 1.)

Type collected on leaf of some unknown host by Dr. F. W. Pennell, in Colombia, altitude 100-300 m., March 7-10, 1918.

DISTRIBUTION: Known only from the type collection.

This species with its unique and striking pattern was collected by Dr. Pennell in the lowland tropical forest of the Rio Sinu, Northern Colombia. Unfortunately we are at present unable to name the host. Dr. Pennell writes: "At the time this was collected the dry season had already begun and there were many leaves on the forest floor. It would likely have been difficult even then to have procured a specimen of tree as in dense forests it is not easy to say from which tree a dead leaf has fallen." So we will necessarily have to wait for further information on this point. There should be no difficulty in recognizing the fungus should it be encountered again.

PHYLLACHORA PERIBEBUYENSIS Speg. Anal. Soc. Ci. Argent. **19**: 244. 1886.

Auerswaldia Miconiae P. Henn. Hedwigia **43**: 253. 1904.

Dothidina peribebuyensis Chardon, Mycologia **13**: 289. 1922.

Stromata numerous, thickly scattered over the under surface of the leaf and slightly visible on the other side, reaching a diameter of 1-2 mm., rough and dull in appearance; loculi subimmersed but prominent; asci cylindrical to clavate, 8-spored; spores 1-seriate or becoming partially 2-seriate, oblique or irregularly disposed, ellipsoid, often slightly constricted in the center. (PLATE 23, F. 7.)

On *Heterotrichum cymosum* (Wendl.) Urban.

Miconia laevigata (L.) DC.

Miconia prasina (Sw.) DC.

Miconia Sintenisii Cogn.

Tetrazygia elaeagnoides (Sw.) DC.

TYPE LOCALITY: South America.

DISTRIBUTION: Porto Rico; continental South America.

PHYLLACHORA PHASEOLI (P. Henn.) Theiss. & Syd. Ann. Myc. **13**: 507. 1915.

Physalospora Phaseoli P. Henn. Hedwigia **43**: 368. 1904.

Hyponectria Phaseoli Stevens, Bot. Gaz. **70**: 401. 1920.

Stromata numerous, thickly gregarious on yellowish spots about 1 cm. in diameter, visible on both sides of the leaf but opening on the upper side, conspicuous, black, shining; asci cylindric or subcylindric, 8-spored; spores 1-seriate, broad-ellipsoid or subglobose, $8-10 \times 12 \mu$. (PLATE 25, F. 2.)

On *Vigna vexillata* (L.) A. Rich.

TYPE LOCALITY: South America, on *Phaseolus* sp.

DISTRIBUTION: Porto Rico, Grenada; also in South America.

PHYLLACHORA RANDIAE Rehm, Hedwigia **36**: 371. 1897.

Trabutia Randiae Theiss. & Syd. Ann. Myc. **13**: 351. 1915.

Stromata on the upper side of the leaves, small, but forming often a number of confluent patches up to 5 mm. in diameter, the patches presenting a convoluted surface, smooth and shining; loculi few to each stroma, strongly protruding; asci clavate, 8-spored; spores rather broadly ellipsoid. (PLATE 28, F. 1.)

On *Randia pubescens* Ruiz & Pav., Bolivia.

Randia mitis L., Porto Rico; Hayti; Trinidad.

TYPE LOCALITY: Bolivia.

DISTRIBUTION: West Indies; also in South America.

PHYLLACHORA SECURIDACEAE P. Henn. Hedwigia 43: 251. 1904.

Stromata sparingly scattered over the leaflets and about equally visible on either side, very small, not exceeding .5 mm. in diameter, slightly convex and dull; loculi few to each stroma, not conspicuous; spores rather small, fusoid or fusiform, about $5-6 \times 15 \mu$. (PLATE 25, F. 1.)

On *Elsola virgata* (Sw.) Kuntze (*Securidaca virgata* Sw.).

TYPE LOCALITY: South America.

DISTRIBUTION: Porto Rico; also in South America.

PHYLLACHORA SIMPLEX Starb. Arkiv. Bot. 5¹⁵: 14. 1905.

Stromata numerous and scattered over the upper surface of the leaf but also visible on the under side, very small, only about 3 mm. in diameter, occasionally several confluent along the midrib of the leaf, usually nearly circular, conspicuous and shining; loculi few, 1-3 in each stroma, the necks of the ostiola prominent; asci club-shaped, 8-spored; spores bunched or irregularly disposed in the ascus, narrow-ellipsoid or more attenuated at one end. (PLATE 23, F. 6.)

On *Coccolobis laurifolia* Jacq.

TYPE LOCALITY: Paraguay.

DISTRIBUTION: Porto Rico; continental South America.

PHYLLACHORA TRAGIAE (Berk. & Curt.) Sacc. Syll. Fung. 2: 601. 1883.

Dothidea Tragiae Berk. & Curt. Jour. Acad. Nat. Sci. II. 2: 288. 1853.

Spots scattered, small, black, shining, surrounded by a very narrow whitish area, reaching a diameter of 1 mm., visible on both sides but more distinct on the under surface; perithecial cavities closely crowded, usually about 6-10 to each stroma; asci clavate, 8-spored, $18-20 \times 90 \mu$; spores ellipsoid, filled with small granules, $7-8 \times 14-16 \mu$. (PLATE 25, F. 3.)

On *Croton lucidus* L., Porto Rico.

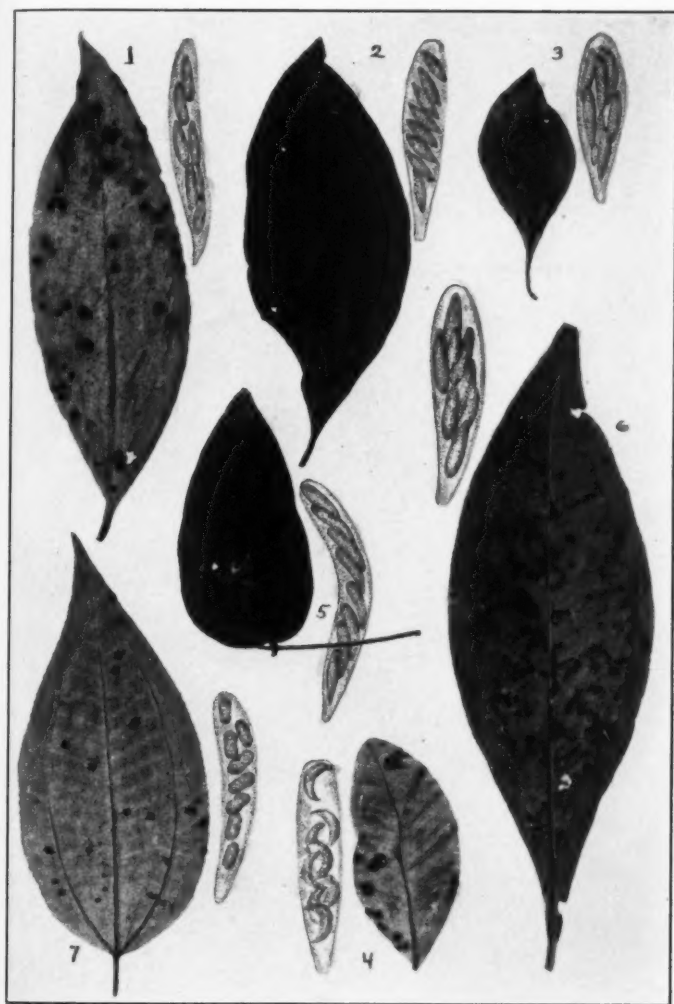
Croton flavens L., Porto Rico.

TYPE LOCALITY: South America.

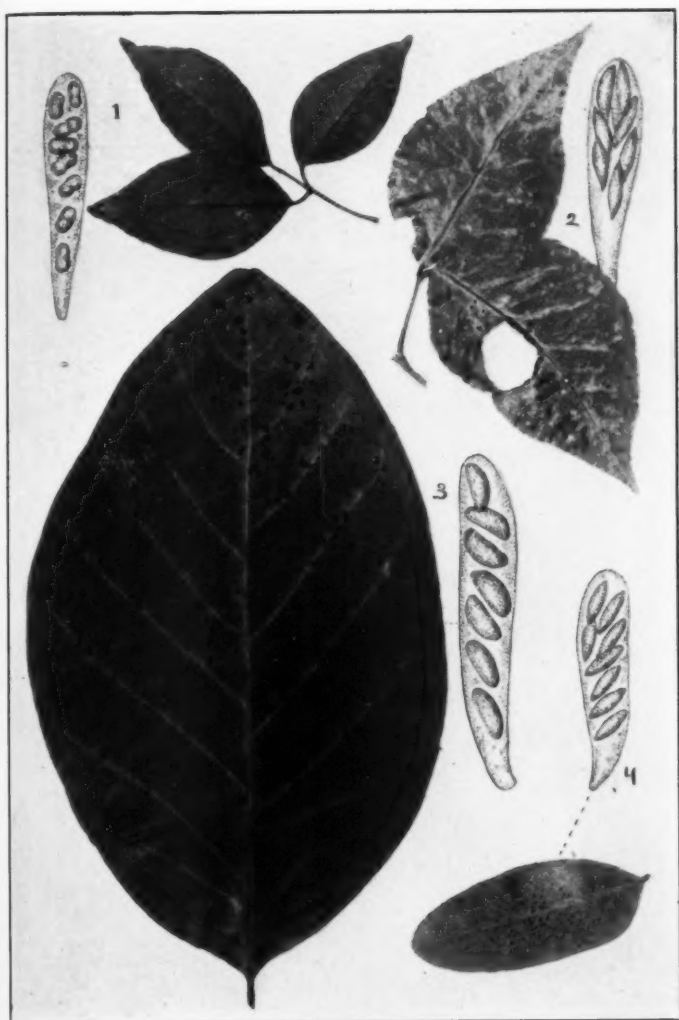
DISTRIBUTION: Porto Rico; also South America and Panama.

PHYLLACHORA ZANTHOXYLI Winter; Rab.-Wint. Fungi Eur. 3558. 1886.

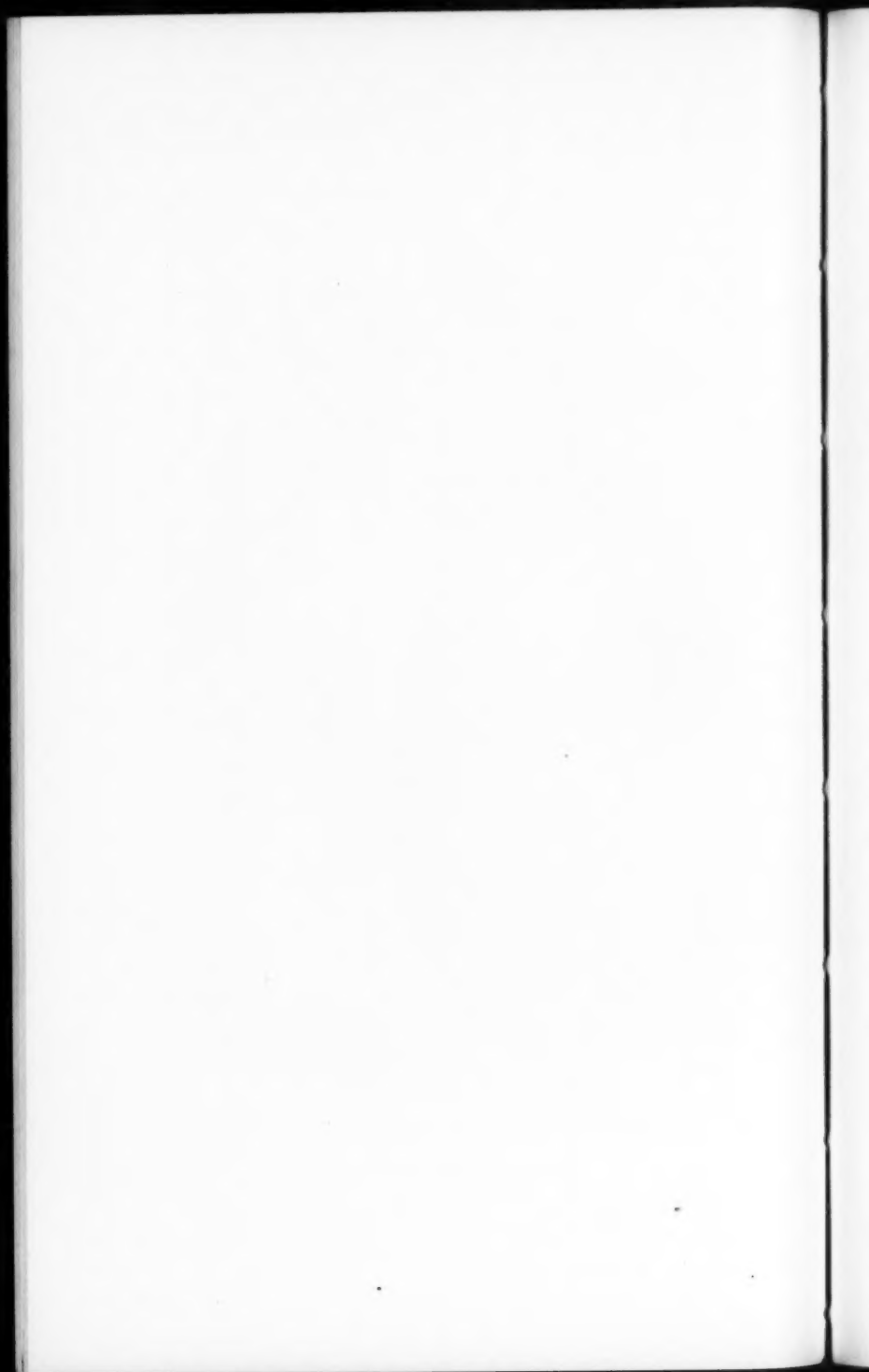
Trabutia Zanthoxyli Chardon; Seaver & Chardon, Sci. Surv. Porto Rico 8: 55. 1926.

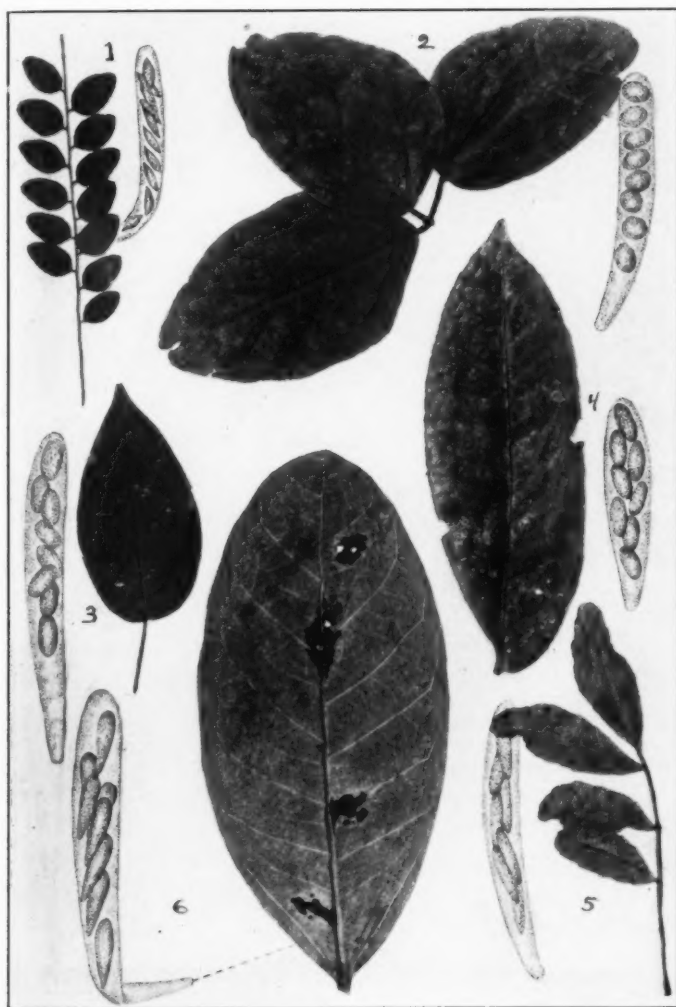


SPECIES OF PHYLLACHORA

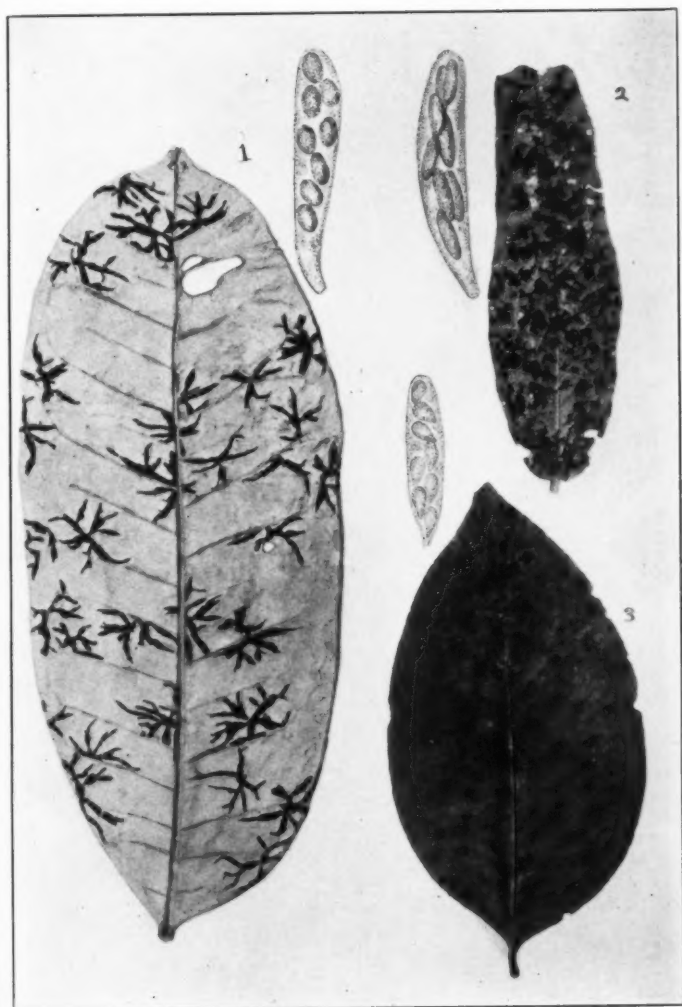


SPECIES OF PHYLLACHORA

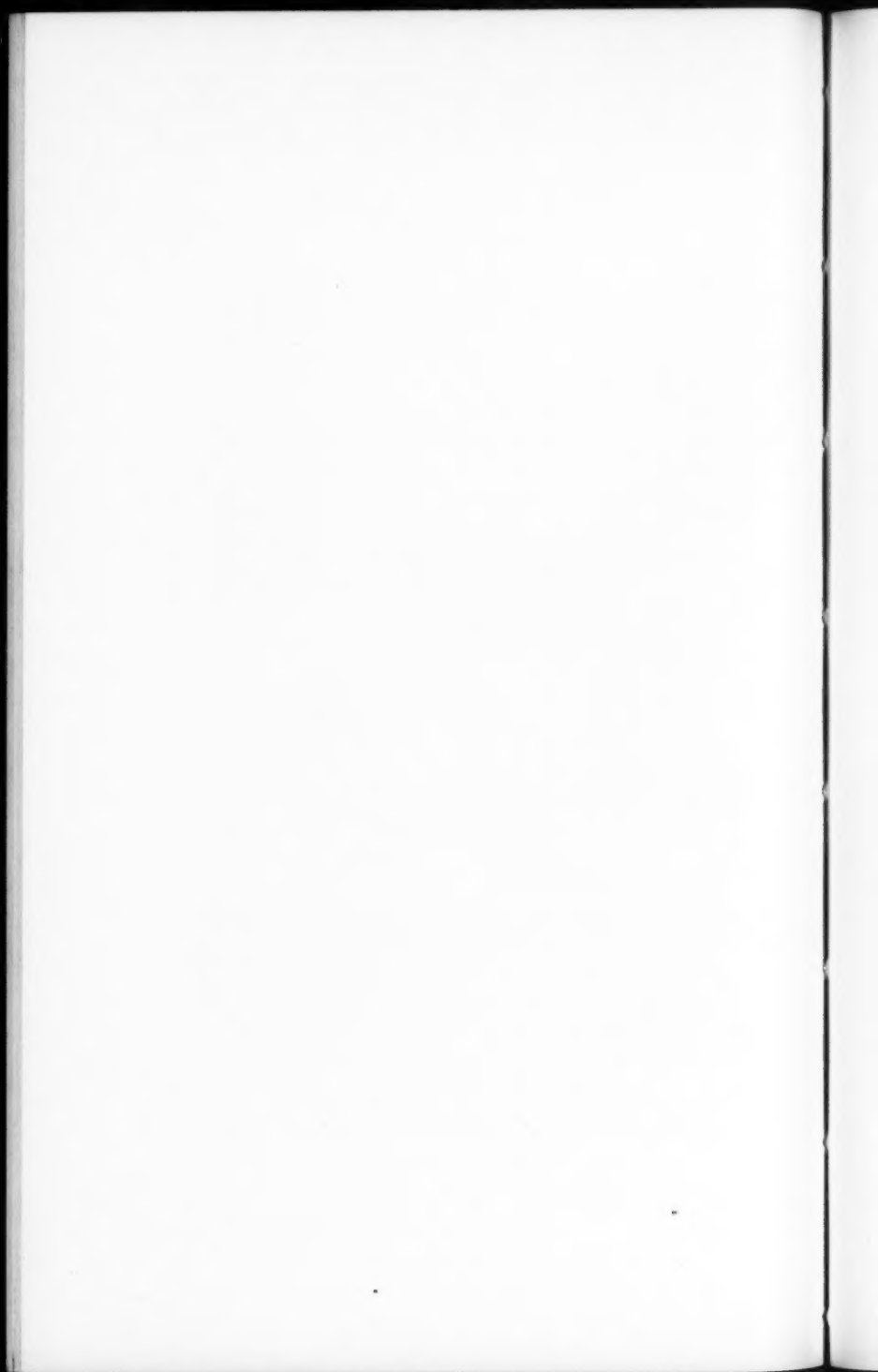


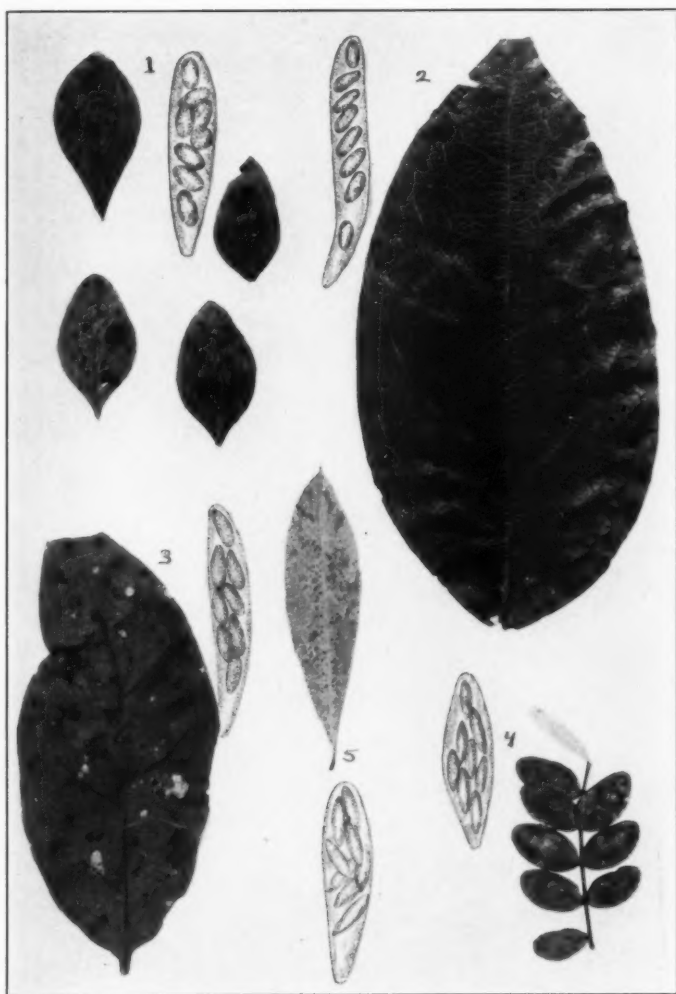


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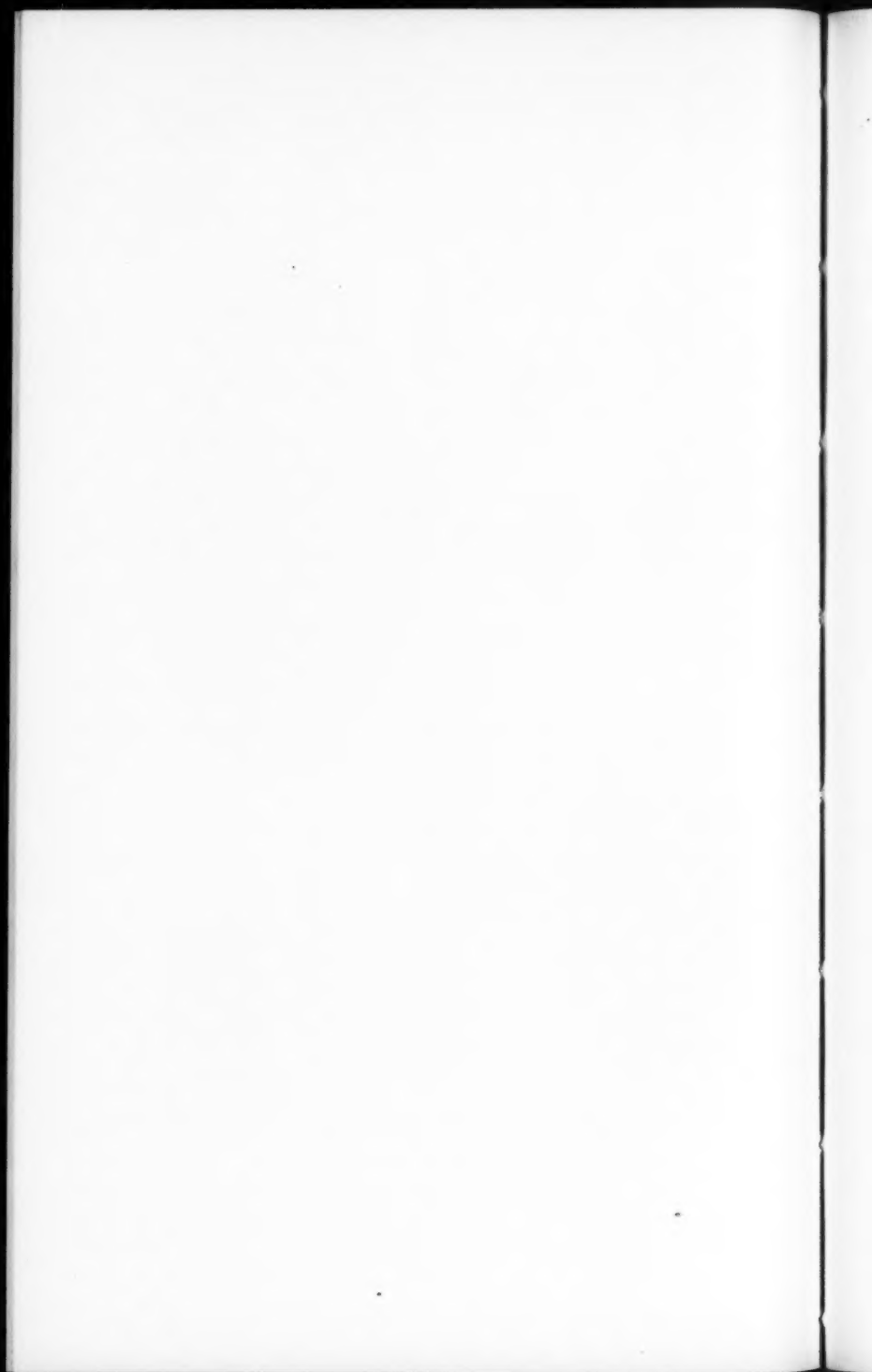


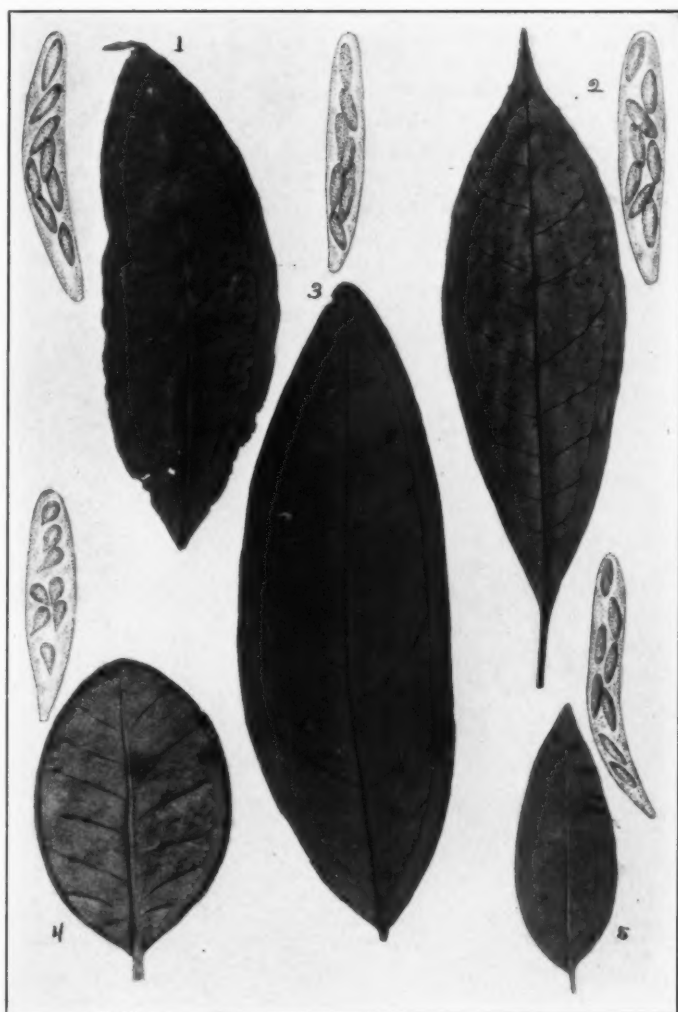
SPECIES OF PHYLLACHORA



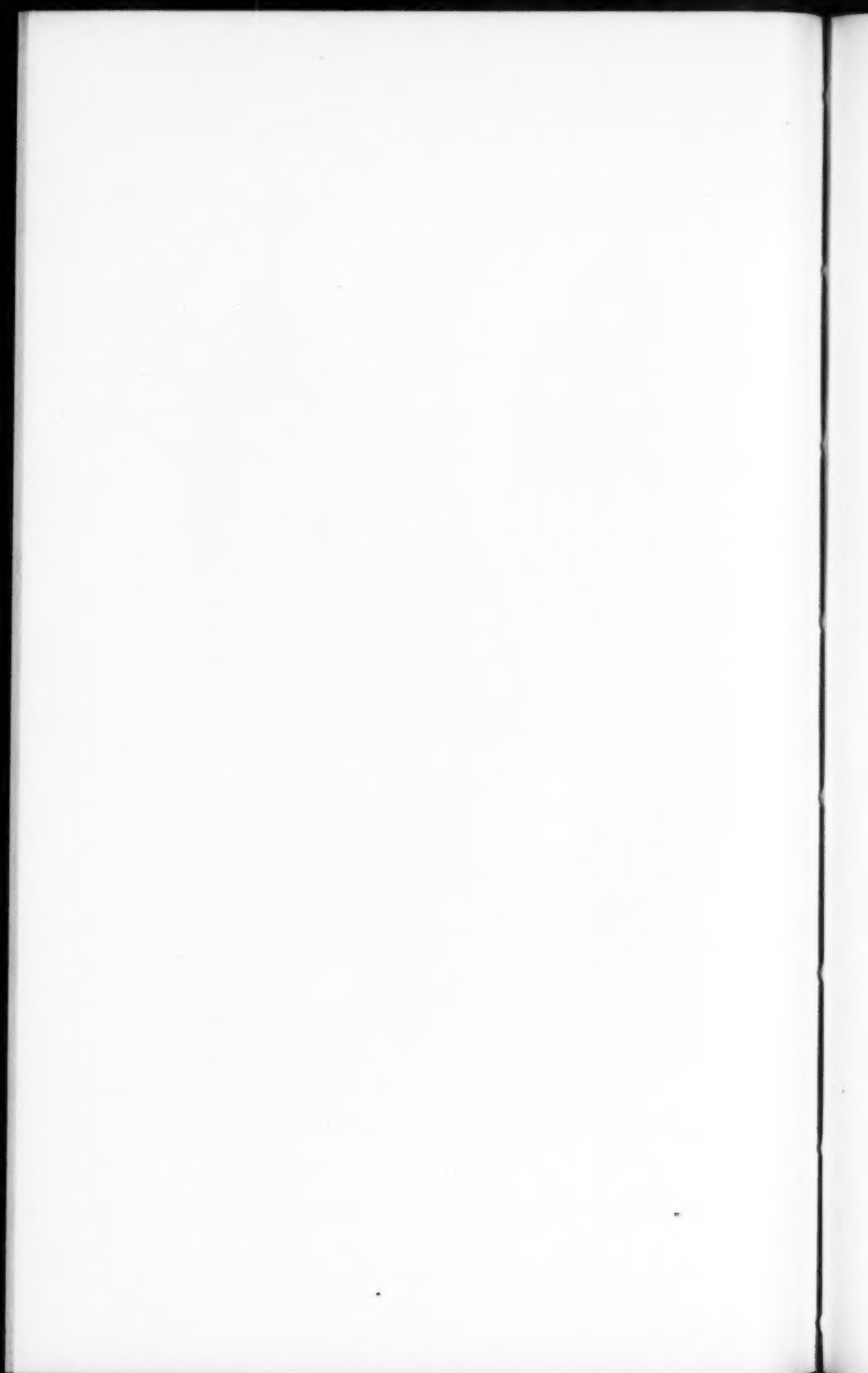


SPECIES OF PHYLLACHORA





SPECIES OF PHYLLACHORA



Stromata occurring on the upper side of the leaf, often on discolored spots, small, rounded or fused together in irregular patches, usually not over 1 mm. in diameter, conspicuous, rather dull; loculi few to each stroma, the ostiola conspicuous; asci subcylindric, 8-spored; spores 1-seriate or partially 2-seriate, ellipsoid, about $6-7 \times 12-18 \mu$. (PLATE 25, F. 4.)

On *Zanthoxylum martinicense* (Lam.) DC.

TYPE LOCALITY: South America.

DISTRIBUTION: Porto Rico; also in South America.

***Phyllachora zanthoxylicola* sp. nov.**

Stromata scattered, usually only two or three on a leaflet, nearly circular in form, visible on both sides of the leaf, black, dull, about 1 mm. in diameter; loculi several to each stroma, the necks of the ostiola visible but not prominent; asci clavate, 8-spored; spores usually 2-seriate or irregularly disposed, fusoid, very long, about $7-8 \times 30 \mu$. (PLATE 25, F. 5.)

Type collected on *Zanthoxylum insulare* Rose in Jamaica. (E. G. Britton 443.)

DISTRIBUTION: Known only from the type locality.

THE NEW YORK BOTANICAL GARDEN

UNISEXUAL CONIDIA FROM BISEXUAL MYCELIA

B. O. DODGE

(WITH 1 TEXT FIGURE)

The opinion prevails, in the absence of adequate proof to the contrary, that a heterothallic or a homothallic species of the Mucoraceae remains fixed so far as this particular characteristic is concerned. Only unisexual spores are developed in a sporangium of *Phycomyces nitens*. Only bisexual spores are formed in a sporangium of *Sporodinia grandis*. Species of the ascomycete genus *Neurospora* produce conidia of the *Monilia sitophila* type.¹ *Neurospora sitophila* and *N. crassa* are heterothallic; therefore, in order to obtain perithecia it becomes necessary to mate in culture a pair of haplonts, "A" and "B," which may be conceived as being of opposite sex. It is customary to obtain such unisexual mycelia by germinating ascospores.

A very interesting question arises when one considers the nature of the conidia produced in a mixed culture containing two mycelia of reciprocal sexuality. Clearly each mycelium produces very early its own unisexual conidia. One naturally assumes that in such a culture there would occur hyphal fusions particularly between branches which are of opposite sex. In that case, do such fusion cells bud out and finally produce bisexual conidia? *Neurospora tetrasperma* is ordinarily homothallic. A monosporous mycelium produces perithecia under proper cultural conditions. By selecting an abnormally small ascospore to be found in almost any spore print, one obtains a mycelium which develops perithecia only when mated with another haplont of the opposite sex. In other words, by properly selecting ascospores one can secure heterothallic strains of a species which is commonly homothallic. The writer has recently shown why the

¹ Shear, C. L. & Dodge, B. O. 1927. Life histories and heterothallism in the red bread-mold fungi of the *Monilia sitophila* group, Jour. Agr. Research 34: 1019-1042, illus.

small ascospores are unisexual.² The change from homothallism to heterothallism is merely a temporary one, although the originally isolated unisexual mycelia must continue to be heterothallic. One has only to mate two such mycelia in culture and then germinate one of the ascospores from a four-spored ascus in order to recover a homothallic strain. Since it may be presumed that it is the natural thing for *N. tetrasperma* to produce bisexual conidia, one would expect that if he gave the hyphae of two haplont mycelia of reciprocal sexuality a chance to anastomose, new branches of a secondary or homothallic mycelium would arise, and would then later produce bisexual conidia. This would certainly be more logical than to expect that hyphae of reciprocal haplonts of normally heterothallic species would fuse in culture and then develop secondary mycelia capable of producing bisexual conidia.

Even though it is the natural thing for a homothallic mycelium to produce bisexual spores, does not *Neurospora tetrasperma* sometimes produce abnormal conidia just as it does abnormal ascospores? There are, then, two questions to be answered. First, does a homothallic (bisexual) mycelium ever produce unisexual conidia; and second, do hyphal branches of a unisexual mycelium, which one may call haplont A, anastomose in culture with hyphae of haplont B and this result in the production of bisexual hyphal branches and conidia? Results of culture work presented in this paper show that while the first question can be answered in the affirmative, the second probably must be answered in the negative.

Single ascospore cultures were made by germinating what were judged to be normal homothallic spores of *Neurospora tetrasperma*. Of some 50 such cultures only one failed to produce perithecia and it was discarded. In applying methods for germinating ascospores, as originally worked out by the writer,³ to these *Monilia* forms whose perfect stages are species of the genus *Neurospora*, it should be borne in mind that the ascospores may be stimulated

² Dodge, B. O. 1927. Nuclear phenomena associated with heterothallism and homothallism in the ascomycete *Neurospora*, Jour. Agr. Research 35: 289-305, illus.

³ Dodge, B. O. 1912. Methods of culture and the morphology of the archicarp in certain species of the Ascobolaceae. Bull. Torrey Club 39: 139-197, illus.

to germinate by subjecting them to a degree of heat which would not be sufficient to kill the conidia which are also very resistant to heat. The point to be emphasized here is that not only may the heating fail to kill the conidia, but it may actually delay their germination for a considerable length of time so that in selecting a single germinating ascospore one has to guard against the carrying over of a very small ungerminated conidium which would later on, perhaps after three or four days, germinate and involve him in errors.

Using a suspension of conidia obtained from one of the fertile cultures containing homothallic mycelia, plates were poured, and 31 single conidium mycelia were isolated. Of this number 21 produced perithecia. The other 10 produced conidia and numbers of the sterile bodies characteristic of haplont mycelia, but no perithecia. Again selecting at random a second generation culture from among the 21 fertile cultures that had developed ascocarps, another set of poured plates containing conidia from the chosen culture was made. Twelve of the 21 mycelia arising from single conidia which were isolated produced perithecia, and 9 did not. Selecting a culture from among the 12 fertile cultures of the third generation, poured plates were again made of conidia, and 80 additional mycelia originating from single conidia were isolated. Of this number, 61 produced perithecia and 19 developed only the sterile bodies and conidia. A fourth set of 23 single conidium mycelia was obtained in a similar manner. Sixteen cultures matured perithecia and 7 did not. The average production of unisexual conidia by the 155 homothallic mycelia was, in these experiments, 29 per cent, which is certainly a surprisingly high percentage. These results were later checked up by a new set of cultures starting with a single ascospore. The germinating spore was transplanted to cornmeal agar in a petri dish and allowed to grow for about 24 hours during which time it was examined at intervals to determine whether any conidia had been carried over by mistake. The tip end of a hyphal branch which could be traced back directly to the ascospore was then cut off and transferred to agar in a test tube.

By the time the culture was 6 days old perithecia had begun to mature and conidia from the tube were sowed on the surface of

cleared cornmeal agar at 10 A.M. The plates were set in a warm room. About 6 hours later when it was found that some of the conidia were growing, 24 single germinating conidia were isolated and planted on cornmeal agar in tubes. The plates from which the conidia had been obtained were placed in an ice box until 12 M. of the following day. Many conidia which had not germinated the preceding afternoon were now beginning to grow so that 18 additional single conidium cultures were obtained. They were examined 6 days after the last isolations were made. While the source of the two sets of cultures was the same, the results were not at all comparable. Of the 24 cultures constituting the first set, 21 developed perithecia and only 3 or about 11 per cent remained sterile. At the same time perithecia were produced in only 6 of the 18 cultures of the second set. Twelve cultures remained sterile, and two-thirds of the mycelia of the second set were thus proved to be unisexual. The average production of unisexual conidia as shown for the two sets was 37.7 per cent. The experiment was repeated under about the same conditions with practically the same results.

The following suggestion is offered to account for the discrepancy. A large conidium provided with two or more nuclei would contain more food and, being more vigorous, would germinate more quickly, particularly if the nuclei were of opposite sex, than would the smaller conidia. If the same plate were examined 24 hours later, it would be found that the germ tubes from conidia that had germinated the previous day would have been so long and much branched as to make their isolation impracticable. The unisexual conidia being the last to germinate would be the ones chosen the second day, thus accounting for the $66\frac{2}{3}$ per cent unisexual mycelia obtained in the second set.

By growing or pairing separately 19 of the unisexual mycelia secured in the way described above with strains S_6 and S_{11} ,⁴ it was found that 12 were sexually like S_6 and 7 were like S_{11} . The others were not tested out.

An explanation to account for the development of unisexual

⁴ The reader will find a discussion of culture methods employed and an explanation of the terms used here in a paper by the writer on "The production of fertile hybrids in the ascomycete *Neurospora*," Jour. Agr. Research 36: 1-14, 1928. illus.

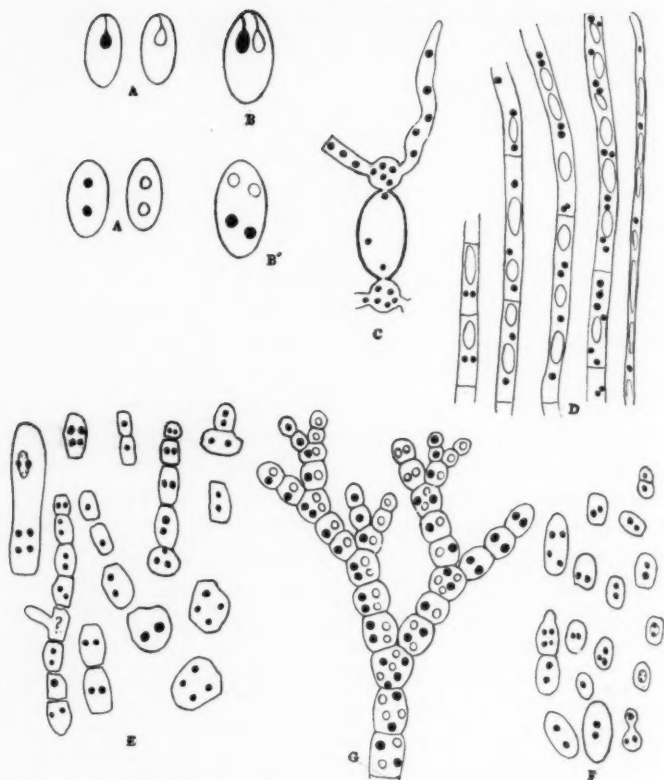


FIG. 1. A to F. Diagram of nuclear condition in cells and spores of *Neurospora tetrasperma*, magnifications not definite; G purely theoretical: A, young unisexual ascospores; A', same spores mature; B, young bisexual spores; B', mature spores; C, germinated ascospore, no cross walls in the young germ tubes; D, young hyphae, position of vacuoles and nuclei shown diagrammatically; E, conidia and fragments of sporogenous hyphae from a homothallic mycelium; F, from unisexual strains showing paired nuclei, a few with a single nucleus; G, diagram suggesting how unisexual conidia might be formed on homothallic mycelia (male nuclei are indicated in black, and female in white); at the right, binucleate conidia would be bisexual, only uninucleate conidia unisexual.

conidia by homothallic mycelia is not difficult to find. Segregation of the sex factors takes place during nuclear divisions in the ascus, so that, preceding spore formation, the ascus contains four nuclei of each sex. The normal ascospore contains two nuclei of opposite sex at its origin (FIG. 1, *B*). Each of these nuclei divides as the spore matures so that each ascospore finally contains four nuclei (FIG. 1, *B'*). The wall of the spore is rather thick, and the spore does not swell very much as it begins to germinate. Instead, a rather large vesicle is formed by the extrusion of some of the spore contents through the germ pore. Stained preparations show that the vesicle contains several nuclei, sometimes as many as 8 or 10 (FIG. 1, *C*). Germ tubes then grow out from the vesicle in two directions. The cells of the mycelium would naturally contain both kinds of nuclei. Should there be anything corresponding to conjugate nuclear divisions as hyphal branches are developed, each conidium should receive at least one pair of nuclei of opposite sex (FIG. 1, *G*⁵). If the divisions are merely simultaneous, or if they occur irregularly, then by the laws of chance some conidia should be bisexual and others should be unisexual. There is always the possibility that a conidium would be cut off with only a single nucleus and if there had been no nuclear fusions during the development of the mycelium every conidium of this sort would be unisexual.

There is a close correlation between the size of an ascospore of *Neurospora tetrasperma* and the number of nuclei it contains. The small uninucleate, unisexual spores are about 20 to 25 μ long. This is about the size of the ascospores of *N. sitophila*. Spores that have four nuclei when they are cut out are between 40 and 50 μ long. Some asci produce only a single giant spore which contains all eight nuclei. If one compares the conidia of *N. sitophila*, which are of course unisexual, with the bisexual conidia of *N. tetrasperma*, he finds that the conidia borne on the unisexual mycelium of the former species are about the same size as the ones borne on the bisexual mycelium of the latter species. Conidia of these forms vary exceedingly in size. Furthermore it is difficult to determine which structures are conidia and which ones are merely the *Oidium*-like fragments of hyphal branches. For this

⁵This figure is not intended to show the order in which conidia are produced.

and other reasons a statistical study of sizes of conidia of different types of mycelia is likely to prove unsatisfactory.

As the writer will be unable to continue this work, he is reporting at this time results obtained in a preliminary study of the cytology of mycelia and conidia which may be suggestive. A glance at material stained in toto with acid fuchsin and iodine green shows that the cells of the homothallic strains ordinarily contain from two to six or eight nuclei, more or less paired as indicated in the diagram (FIG. 1, *D*). This figure shows merely the location of the nuclei and vacuoles. In very fine, slender hyphae nuclei may occur singly and widely separated. Here the cross walls are difficult to locate with certainty.

Preparations in which the conidia and fragments of sporogenous hyphae were stained by the same method indicate that there is also great variability in the number of their nuclei. Some of the larger cells at the base of branches made up of spore chains may contain four nuclei. These cells germinate the same as conidia under proper conditions. One frequently finds chains made up of *Oidium*-like cells, each cell containing a pair of nuclei (FIG. 1, *E*). Occasionally a conidium contains only a single nucleus. In this case the spore is rather small. One is inclined to assume that, since the nuclei occur so frequently in pairs in the homothallic structures, the pairing must be due to something which corresponds to conjugate division, particularly as about 75 per cent of single-conidium mycelia are bisexual. On the other hand, when one stains conidia developed on unisexual mycelia, he finds many binucleate spores. In fact, it is rather difficult to find spores with only one nucleus. This is especially true for conidia developed in potato dextrose cultures, where the hyphae, and therefore the conidia, are rather coarse or thick. It would be difficult to tell by the number of nuclei in the conidia whether the preparations were made from conidia formed on bisexual mycelia grown on cornmeal agar cultures or from conidia developed from unisexual mycelia grown on potato dextrose agar.

Since the binucleate conidia borne on unisexual mycelia must be unisexual, it cannot be denied that a binucleate condition may exist merely by the inclusion of two sister nuclei in each cell. This might be due to the fact that each cell originally contains a

single nucleus which later divides; which suggests perhaps that the theory of conjugate division in mycelial cells of the bisexual strains does not necessarily hold. To this it may be objected that if the nuclear divisions were merely simultaneous or occurred irregularly and the nuclei were distributed in the conidia merely by chance, one ought to find more than 25 per cent of the conidia unisexual. The evidence presented here certainly favors the idea that something corresponding to conjugate nuclear division in cells of the homothallic mycelia does take place. Mature unisexual ascospores of this species are binucleate. It would seem that full-sized conidia require at least two nuclei to maintain the nucleo-cytoplasmic equilibrium. A bisexual ascospore is much larger than are the unisexual ascospores, hence its four nuclei at maturity. It is very doubtful whether such a difference exists between unisexual and bisexual conidia.

Only a comparatively small number of preliminary culture experiments have been carried out in the attempt to answer the second question previously raised, namely, in mixed cultures containing two sexually reciprocal haplont mycelia of *Neurospora tetrasperma* are there anastomoses or fusions of unisexual hyphal cells followed by the production of secondary bisexual mycelia which produce homothallic or bisexual conidia? Using conidia obtained from fertile mixed cultures containing haplonts S₆ and S₁₁, some 250 single conidium mycelia were isolated at various times. No evidence has been obtained so far to indicate that bisexual conidia are developed in such mixed cultures. Since haplont B produces a great many more conidia than haplont A, it was to be expected that a large proportion of the isolated mycelia would be sexually like haplont B. Only 3 out of the 250 were like haplont A. Since each of the unisexual mycelia would begin at once to produce its own kind of conidia in a mixed culture, it is very evident that even if later some bisexual conidia were developed they would be greatly outnumbered by the unisexual conidia produced when the culture was fresh. This would mean that results in order to be convincing must be obtained from a much larger number of cultures, which would not be at all necessary in proving that homothallic mycelia produce some unisexual conidia.

In conclusion it may be stated that the culture experiments reported here prove that a homothallic mycelium of *Neurospora tetrasperma* produces, in addition to the bisexual conidia to be expected, some unisexual conidia. No evidence has been obtained to show that bisexual conidia are produced in mixed cultures containing two heterothallic mycelia of opposite sexuality.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

NEW AND NOTEWORTHY FUNGI—V¹

JOHN DEARNESS

DEUTEROMYCETES

SPHAEROPSIDALES

Stagonospora Amorphae Dearn. & Bisby, sp. nov.

Pycnidia scattered, covered by the epidermis which is ruptured only by the slight ostiolum, rather flat, mostly elliptical, reaching $340 \times 180 \mu$, depth 100μ ; wall dark, thin, membranous, thicker on top. Conidia almost sessile on the thin cellular layer lining the wall, hyaline, cylindric, 4-celled, usually 2 oil drops in each cell, $42-56 \times 4-6 \mu$.

Apparently causing "die-back" of green twigs of *Amorpha fruticosa*; Winnipeg, Man.; Aug. 1925; Sept. 1927. G. R. Bisby: 2547, 3633. (D. 5924.)

Stagonospora lapidoviridis sp. nov.

Spots subcircular or irregular, becoming confluent, slaty-green or watery-green, retaining their color after the leaf has become yellow or sere, .5-2 cm. Pycnidia innate, opening on the upper side, hyaline, $30-120 \mu$; wall thin, obscure, a single layer of hyaline cells. Conidia few, large, lunate, hyaline, sometimes granular, $22-36 \times 8-15 \mu$, 3-celled, the middle cell always the largest, sometimes as much as 20μ long; central conidiophores short, outer ones up to $30 \times 3 \mu$.

Parasitic on leaves of *Smilax herbacea*; Byron, Ont.; Sept. 25, 1924. Dearness: 5676.

S. Smilacis has ovate spores, $11-22 \times 6-7 \mu$.

Stagonospora Phaseoli Dearn. & Barth. sp. nov.

Spots arid or whitish with red border on upper side of the leaf, similar but duller below, scattered and becoming numerous, mostly circular, 5-10 mm. in diameter. Pycnidia black, innate, conspicuous above, can be seen from below, subglobose, $150-225 \mu$, often with a few bristles around the mouth; wall thin, of brown cells, $7-9 \mu$; bristles when present 4-10, septate, obtuse, $50-170$

¹ Continued from MYCOLOGIA 18: 255. 1926.

$\times 4 \mu$ at top and $8-10 \mu$ at base. Conidia hyaline, subcylindric, continuous to 5-septate, grumous and guttulate, $21-37 \times 4-6 \mu$.

Parasitic on cultivated beans—*Phaseolus vulgaris*—and associated on most of the leaves with *Cercospora canescens*; Greenfield, Tenn.; Sept. 28, 1925. E. Bartholomew: 9290. (D. 5755.)

Hendersonula pinicola sp. nov.

Stromata dark brown, covering the full width of the needle and when confluent resembling the dark crust of *Hypoderma (Bifusella) lineare*. Loculi scattered, $110-135 \mu$ in diameter, visible as pustules rising above the level of the crust. Conidia dark-amber color, fusoid, mostly 2-septate, slightly constricted, sessile, $12-15 \times 3-3\frac{1}{2} \mu$.

On partly green needles of *Pinus Strobus*; Davidson River, N. C.; Aug. 6, 1925. G. G. Hedgcock: 43031. Also at Brevard, N. C., and Roan Mtn., Tenn. "A needle blight cast"—G. G. H. As this was mixed with other species its parasitism cannot be strictly defined. (D. 5864.)

Camarosporium Betulae Dearn. & Barth. sp. nov.

Pycnidia scattered, developing in the phloem and raising the epidermis into truncate-conical pustules, .6-.8 mm. in diameter at the base, opening by a large perforation, 200μ , through a white or pale-buff disk; sometimes in small, confluent, *Dichomera*-like groups. Conidia brown, ovate to oblong-elliptic, 3-5-septate, longitudinal septa joining one or two pairs of transverse ones, rarely extending more than half the length, many merely phragmosporous, $15-24 \times 5-9 \mu$, sessile on a rather thick, white, cellular lining of the wall.

On dead branchlets of *Betula populifolia*; Queenston, Ont.; July 21, 1913. E. Bartholomew: 5102. (D. 4579.)

Septoria Boycei sp. nov.

Spots pale reddish-brown above, duller below, scattered, numerous, circular at first, 1 mm. in diameter, extending between the large veins, seldom crossing them, reaching 7.5 mm. Pycnidia epiphyllous, thinly scattered, dark, small, $40-90 \mu$, many of them rather widely open at the top; wall thin, of one layer of quadrate cells. Conidia hyaline, strongly curved or flexuous, $30-70 \mu$, mostly between 45 and 60μ by 2 to $2\frac{1}{2} \mu$, 1-3-septate.

Parasitic on leaves of *Betula fontinalis* Sarg.; Clackamas Co.,

Oreg.; alt. 4,000 ft.; July 8, 1924. J. S. Boyce: 1291. (D. 5670.)

This is different from each of the four *Septoriae* on *Betula* described in the Sylloge. The pycnidia are so widely open in some of the spots that they might be sought in *Phleospora*.

***Septoria Ceanothi* sp. nov.**

Spots scattered, circular, numerous, small, 1 mm., whitish, red-bordered, similar on both sides. Pycnidia black, punctate, one or a few on a spot, mostly single and central, epiphyllous, 100–120 μ . Sporules hyaline, curved, $20\text{--}36 \times 1 \mu$.

Parasitic on leaves of *Ceanothus sanguineus* Ph.; Bonner Co., alt. 3,000 ft.; July 27, 1924. J. S. Boyce: 1289. (D. 5669.)

Cylindrosporium Ceanothi Ellis & Ev. On dark spots has spores 4 μ wide.

SEPTORIA LYCHNIDIS Desm.

On living leaves of *Lychnis alba*; Mattituck, N. Y.; Oct. 1, 1923. Roy Latham. (D. 5442.)

Spots brown-red. Conidia $40\text{--}65 \times 2\frac{1}{2} \mu$, 5–7-septate. This European species does not seem to have been hitherto reported in America.

***Septoria pinicola* sp. nov.**

Pycnidia amphigenous, mostly on the external side of the needles, scattered, often serried in short lines, the black top barely visible through narrow cleft of the slightly pustuled epidermis, seated in the browned or blackened hypoderm, globose, 90–165 μ ; wall black, 35–55 μ thick. Conidia hyaline, granular and often with a row of minute guttae, straight or curved, one or both ends somewhat narrowed, continuous or uniseptate, $30\text{--}60 \times 3 \mu$, mostly between 45 and 50 μ long, on short conidiophores arising from a thick, rather compact pseudo-parenchyma lining the wall.

On blighted needles of the lower limbs of forest trees, *Pinus virginiana*; Chain Bridge, Va.; May 10, 1927. G. G. Hedgcock: 3455. (D. 5837.) There were no green or partly green needles on the twigs received. While the general appearance of the needles was brown, those bearing numerous pycnidia were grayish and often dark-banded. If *Septoria spadicea* Patterson & Charles is a very variable species, this may be an extreme form of it.

Septoria septoriopsisidis Dearn. & Overh. sp. nov.

Spots pale reddish-brown, immarginate, circular or irregular, 4-10 mm., surrounded as seen when held to the light with a yellowish or discolored area 2 to 4 mm. wide, similar on both sides. Pycnidia strictly epiphyllous, in the palisade tissue, 60-115 μ , globose at first, becoming saucer-like and superficial and then bearing dense, white tufts of conidia simulating *Septoriopsis* (*Cercoseptoria* Petrak), Mycologia 11: 4. Conidia straight or slightly curved, 1-3-septate, $14-27 \times .5-75 \mu$, on a layer of cells and filiform sporophores about 30 μ thick.

Parasitic on leaves of *Betula lenta*; Center Co., Pa.; July 28, 1924. R. S. Kirby and L. O. Overholts: 9547. (D. 5705.)

Septoria Shepherdiae (Sacc.) Dearn. comb. nov.

Cylindrosporium Shepherdiae Sacc. Ann. Myc. 11: 551. 1913.

Dr. Saccardo founded this species on a Field, B. C. collection of leaves of *Lepargyrea canadensis* which I sent him in 1912. (D. 3477.) In an Idaho collection of the same species, J. S. Boyce: 1290, as well as in stained trans-sections of the co-type, I find a thin undarkened pycnidial wall. The species should be classified as a *Septoria* and the width of the conidia stated as 2 μ instead of 3-4 μ unless the jelly-sheathing be included.

Septoria Sonchi-arvensis Dearn. & Bisby, sp. nov.

Spots round, 2-4 mm., with broad, red-brown margin. Pycnidia mostly epiphyllous but variable in this particular, dark, few on a spot, 150 μ . Conidia hyaline, septate, $20-42 \times 2\frac{1}{2} \mu$ at one end and $1\frac{1}{2} \mu$ at the other, sometimes even.

On *Sonchus arvensis*; Winnipeg, Man.; June-Sept. 1925. Bisby and Conners: 1573, 2379. (D. 5868.) *S. sonchifolia* Cooke is also existent in the same region.

Septoria sitchensis sp. nov.

Spots small, 2-4 mm. across, limited by the veinlets, not bordered, widely scattered, red above, yellow below and blackened by the pycnidia if they happen to be close together. Pycnidia usually few on a spot, large, reaching a width of 225 μ and a depth of 150 μ , innate, visibly bulging the cuticle on the lower side of the leaf, reaching and opening through but not elevating the cuticle on the upper side; wall 33 μ thick at base; under the hand lens seeming to be hypophyllous. Conidia hyaline, curved or flexuous, $45-90 \times 3 \mu$, attenuating towards the distal end to

1.5 μ . The conidia continuing adnate to their conidiophores with the basal layer can be removed from some of the pycnidia and transferred in liquid from place to place.

On living leaves of *Pyrus sitchensis* (Roem.) Piper; Upper Priest River, Ida.; July 30, 1924. C. R. Stillinger: 2142. Beaton, B. C.; Aug. 25, 1926. J. S. Boyce: 1670. (D. 5802.)

Rhabdospora aristata Dearn. & Barth. sp. nov.

Pycnidia scattered, sub-cuticular, dark brown, firm, ostiolate, hemispheric to conic, sometimes centrally depressed, .25-.5 mm. Sporules hyaline, consisting of a narrow-fusoid, 1- to 4-septate, weakly curved portion, $20-30 \times 2\frac{1}{2}-3 \mu$, basally contracting into an acuminate, curved, aristiform pedicel, $20-30 \times .5 \mu$.

On dead stems of *Heracleum lanatum*; Choteau, Mont.; Aug. 9, 1917. J. A. Hughes, J. R. Weir: 9183. (D. 4591.)

Rhabdospora Eucalypti Dearn. & Barth. sp. nov.

Pycnidia thickly scattered, erumpent, 100-150 μ , contents gray in section; wall well developed above, thinning out below; ostiola black, papillate. Conidia hyaline, linear, curved or hamate, $19-22 \times .75-1 \mu$, on linear conidiophores nearly as long and mixed with tongue-like extensions.

On dead stems of *Eucalyptus* sp.; San Francisco, Cal.; Aug. 2, 1924. E. Bartholomew: 8859. (D. 5726.)

LEPTOSTROMATALES

Leptothyrium Pseudotsugae sp. nov.

Sporocarps black, thickly scattered, circular, perforate, not discoloring the leaf, 60-100 μ , many of them infertile. Conidia hyaline, globose, oval or elliptic, $6-8 \times 4-6 \mu$.

A "fly-speck" fungus on living leaves of *Pseudotsuga taxifolia*; Stonewall Gap, Colo.; June 18, 1917. Hedgcock and Bethel: 24,396. (D. 5698.)

Rhabdogloeum Pseudotsugae Syd. on the same collection.

Leptothyrium stenosporum sp. nov.

Pycnidia black, scattered or grouped, circular, often centrally perforate, sub-hemispheric, mostly on paler portions of the inner faces of the needles, $\frac{1}{4}-\frac{1}{2}$ mm. Conidia hyaline, minute, allantoid, $2\frac{1}{2}-4 \times .75-1 \mu$, on fascicled or branched conidiophores up to 9 μ long, branches .5 μ thick.

On blighted needles of small trees, *Pinus Strobus*; Elijay, Ga.; July 27, 1925. G. G. Hedgcock: 11,998. (D. 5904.)

Leptostroma Hedgcockii sp. nov.

Sporocarps same color, shape and size as the apothecia of *Hypoderma hedgcockii* Dearn. Conidia snow-shoe shaped, hyaline, with one large nucleus or two smaller ones in the wider (upper) end, $16-24\ \mu$ long by $4-6\frac{1}{2}\ \mu$ wide in the upper half, contracting to $2-3\ \mu$ at the lower end; on branched or fascicled conidiophores in units up to $30\ \mu$ long, the branches $2\ \mu$ thick.

On living needles of *Pinus rigida* Mill; Andrews, N. C.; July 19, 1925. G. G. Hedgcock: 11,952. (D. 5827.) Collected in as many localities as the ascigerous state; apparently more common. (Mycologia 18: 240.)

(?) **Leptothyrella Laricis** sp. nov.

Leptostromes elongated, narrow, $.25-1 \times .1\ \text{mm.}$, widely cleft, on the inner side of the needles. Conidia hyaline, oblong, usually short-pointed at the ends, 2-septate, guttate, $12-24 \times 4-5\ \mu$, mostly $16-17 \times 4\frac{1}{2}\ \mu$.

Parasitic on needles of *Larix occidentalis* Nutt.; Moscow, Idaho; Sept. 23, 1911. G. G. Hedgcock: 9541. Also 11,117 and other collections. (D. 5691.)

This species in its form is intermediate between *Leptothyrella* and *Cystothyrium*. It is pretty certainly the conidial stage of *Hypodermella Laricis* Tub. var. *octospora* with which it is associated on some of the needles.

Leptostromella Cassiae Dearn. sp. nov.

Pycnidia black, numerous, very thickly scattered, covered by the thin, translucent cuticle, minute, circular to oblong, $.2-.5\ \text{mm.}$ Spores nearly straight to hamate-curved, hyaline, $18-25 \times 1-1\frac{1}{2}\ \mu$.

On dead stems of *Cassia marilandica* L.; Fort Ann, Washington Co., N. Y.; June 1915. S. H. Burnham: 36. (D. 4040.)

Dinemasporium corrugatum Dearn. & Barth. sp. nov.

Pycnidia black, open, setose at base, $80-150\ \mu$, corrugate, involute. Conidia hyaline, widely lunate, ciliate at each end, $5-8 \times 2.75\ \mu$, cilia $3-6 \times \frac{1}{2}\ \mu$; conidiophores fasciculate.

On decorticated *Morus alba*; Stockton, Kan.; March 1924. E. Bartholomew: 8653. (D. 5544.)

MELANCONIALES

Gloeosporium melleum Dearn. & Overh. sp. nov.

Spots amphigenous, circular, 2-5 mm., becoming confluent, cream-colored to dull yellow, mostly obscurely concentrically ridged, the slightly raised border concolorous or somewhat darker. Acervuli amphigenous, or on some spots epiphyllous only, the smaller ones dark and *Phyllosticta*-like, the larger, especially on the lower side of the leaf, honey-colored, 50-210 μ , usually segregated near the middle of the spot. Spores exceedingly numerous, minute, $2\frac{1}{2}$ -3 \times .5 μ .

On living leaves of *Chenopodium album*; Pottstown, Pa.; July 7, 1924. R. S. Kirby and L. O. Overholts: 9690. (D. 5746.)

Gl. Chenopodii has spores 8-9 \times 3-4 μ *vide* Saccardo, Syll. Fungi 10: 44.

Gloeosporium multipunctatum sp. nov.

Spots extensive, immarginate, mostly centered along strong veins for 1-3 cm., brownish, darker above, particularly while the leaf remains green. Acervuli mostly hypophyllous, position visible on upper side, innate, very numerous, more so near the veins, slightly rising above the leaf-level and appearing like minute beads of glue, 20-200 μ . Conidia hyaline, oblong, straight, 6-9 \times $1\frac{1}{4}$ - $1\frac{1}{2}$ μ .

On green and languishing leaves of *Acer saccharinum* L.; Pond Mills, Ont.; Oct. 7, 1924. Dearness: 5678.

Rhabdogloeum abietinum sp. nov.

Affected leaves scattered among green ones, yellowed or sered throughout. Acervuli mostly hypophyllous, raising the epiderm into circular or elongate, concolorous blisters, .5-2 mm. Conidia hyaline, continuous, fusoid, often somewhat curved, 15-21 \times 4-5 μ , on dendriform conidiophores, 1 μ thick, in units about 45 μ high.

Parasitic on needles of *Abies fraseri* (Pursh) Lindl.; Mt. Mitchell, N. C.; Aug. 10, 1925. C. F. Kerstian, G. G. H.: 43,026. (D. 5902.)

Myxosporium megallanto sp. nov.

Acervuli scattered or in series, pustular, sub-epidermal, circular, .5-.7 mm., extending or becoming confluent in sub-parallel lines and raising the epidermis into narrow, low, pale-gray ridges, .5-3 or 4 cm. long by .2-.5 mm. wide at the base.

Conidia hyaline, granular, large sausage or cucumber shape, some straight but oftener curved usually more strongly above, $45-50 \times 12-16 \mu$, either on short conidiophores, $5-15 \times 5-6 \mu$, or terminal on a chain of cells each $5-20 \times 5-8 \mu$, total length $15-100 \mu$, widening upwards, quite probably a chain of incipient conidia. Overtopping the conidia are linear, septate, hyaline paraphyses, $40-150 \mu$ long, 3μ wide at the top and 6μ at the base.

On dead branchlets of *Liriodendron tulipifera*; Southold, N. Y.; Apr. 1923. Roy Latham: 1803. (D. 5526.)

This is an inconspicuous fungus but when opened up is as attractive as it is peculiar. It is anomalous in *Myxosporium*. The total central depth of a large acervulus reaches 240μ .

Myxosporium negundicolum Dearn. & Barth. sp. nov.

Acervuli thickly scattered, on some of the twigs so thickly as to blacken them by the spore masses showing through the translucent cuticle, .4-.8 mm. Conidia hyaline, densely granular, some of them also guttate, sometimes shortly catenate, $24-28 \times 9-12 \mu$, on rather stout conidiophores.

On dead shoots of *Acer negundo*; Blue Rapids, Kan.; June 25, 1925. E. Bartholomew: 9112. (D. 5874.)

Myxosporium roseum Dearn. & Barth. sp. nov.

Acervuli thinly scattered, seated in the cortex, raising the epidermis into round or sub-elongate, centrally depressed pustules, .5-2 mm., from which often issue salmon-rosy cirrhi. Conidia hyaline, oblong, with rounded ends, $15-18 \times 5 \mu$, on simple or branched conidiophores $15-18 \times 2 \mu$.

On dead branchlets of *Ulmus americana*; Stockton, Kan.; Nov. 1923. E. Bartholomew: 8602. (D. 5399.)

Colletotrichum Viciae Dearn. & Overh. sp. nov.

Part or all of the leaf yellowed or whitened. Acervuli scattered, amphigenous, more numerous on the upper surface, as many as 20 on a sq. mm., melleous, $50-90 \mu$ in diameter, but also large and irregular by confluence. Setae lacking or few or numerous, hyaline to fuliginous, reaching a length of 65μ , 6μ at base, tapering to an acute tip, continuous or 1-septate near the base. Conidia hyaline, narrowly crescentic, nucleolate, $17-21 \times 3-4 \mu$.

Parasitic on *Vicia* (?) *villosa*. State College, Pa.; July 14, 1924. C. R. Orton: 9335. (D. 5627.) Affinitive to *C. carpophilum* Kell. & Swingle.

Marssonia Sonchi Dearn. & Bisby, sp. nov.

Spots 3-5 mm., amphigenous, cinereous-brown, purplish-red-bordered, obscurely concentrically zoned, surrounded by a diffuse discoloration 2-4 mm. wide. Acervuli 80-300 μ , mostly epiphyllous, circular or irregular, nearly concolorous, slightly convexing the cuticle. Conidia escaping by a minute perforation, hyaline, 1-septate, constricted, usually one or two guttae in each cell, oblong-elliptic, 10-13 \times 3-5 μ .

On living leaves of *Sonchus arvensis* L. Common in locality of collection. Manitoba Agric. College, Winnipeg; June-Aug. 1924. G. R. Bisby: 1816, 2038. (D. 5793.)

Septogloeum rhopaloideum Dearn. & Bisby, sp. nov.

Spots scattered, numerous, small and limited by the veinlets at first but soon becoming confluent and spreading to occupy most or all of the leaf, watered-gray, more cinereous above. Acervuli hypophyllous, large, numerous, 10-20 per sq. mm., convex until the cuticle ruptures, then dingy-melleous, 200-300 μ . Conidia often emerging in tongue-like masses, hyaline, Indian-club or tadpole shape, pointed end outward, 2-4-celled, mostly 3-celled, 40-60 \times 8-12 μ , the proximal cell short, 6-9 \times 5-7 μ , middle cell largest, 21-30 \times 8-12 μ , distal or tail cell 15-24 μ long and acuminate to a point.

Parasitic on leaves of *Populus tremuloides*; Winnipeg, Man.; Aug. 1924. G. R. Bisby: 1818, 2127. (D. 5794.)

CORYNEUM MICROSTICTUM Berk. & Br. var. **foliae** Dearn. & Overh. var. nov.

A *Coryneum* on cultivated rose leaves with brown, 3-septate spores, 12-15 \times 5 μ , is taken, on morphological grounds only, to be a variety of *C. microstictum* B. & Br., a species producing an injurious canker on rose stems.

The leaf tissue is killed in and beyond the brown-bordered spots. The black, irregular acervuli, 70-200 μ , rupture the cuticle on the upper side. Wrinkling of the cuticle near the margin of the spot causes one or more broad, whitish lines concentric with the raised border.

Parasitic on foliage of *Rosa* sp., cult.; Newcombe, N. Y.; Aug. 8, 1924. C. R. Orton and L. O. O. Overholts: 9714. (D. 5608.)

CORYNEUM SEPTOSPORIOIDES (Ellis & Ev.) Sacc. & Syd.

Coryneum Negundinis Ellis & Ev. Bull. Torrey Club **24**: 292. 1897.

On *Acer negundo*. Collections on still living branches by E. Bartholomew, Ten Sleep Canyon, Wyo.; H. F. Perkins, Prince Albert, Sask.; W. P. Fraser, Saskatoon, show that this fungus can produce a serious canker on branches of the ash-leaved maple. The original description locates it on dead limbs. These had probably been killed by it.

The hyphal features vary in sections from different regions of the canker; some of them suggest *Septosporium*—erect sterile hyphae are to be found—and others *Clasterisporium*. (D. 5430.)

Monochaeta pinicola sp. nov.

Acervuli scattered, amphigenous, black, sub-epidermal, erumpent, punctate, .1 mm., to narrow elongate, 1 mm., sometimes confluent. Conidia ciliate-pedicellate and similarly ciliate at the upper end, curved, brown, 4-celled, the two middle cells dark brown, the other two pale brown and truncate-conic, width at middle septum $5\frac{1}{2}$ – $8\frac{1}{2}$ μ , at the attachment of the cilia 3 μ , length exclusive of the cilia 14–19 μ , the cilia 7–14 \times .75 μ .

On blighted needles of *Pinus palustris*; Hogan, Fla.; March 1918. G. G. Hedgcock: 25,156; on *P. echinata*. G. G. H.: 24,395. (D. 5863.)

Cryptosporium aciculum Thüm.

Septoria acicola (Thüm.) Sacc. Syll. Fung. **3**: 507. 1884.

Parasitic on needles of *Pinus palustris*, Brooksville, Fla., Mar. 11, 1915—(G. G. H.: 17,424)—and in more than twenty other collections made by G. G. Hedgcock on *Pinus* spp.—*laeda*, *echinata*, *glabra*, *virginiana*—in five of the southern States. Labelled "Red spot; common and injurious on young forest trees." (D. 5830.)

There can be found in these collections exemplification of the features of the above-named fungus as described in the Syll. Fungi **3**: 507.

If this is the fungus de Thümen had in hand, the description in the Sylloge may be supplemented as follows:

Acervuli amphigenous, globose at first, 50–100 μ in diam., becoming elongate up to 1.5 mm., seated in the mesophyll,

discharging spores through a cleft of the epidermis. Basal layer of colored, compact pseudoparenchyma. Conidia simple and sub-hyaline, becoming 1-3-septate and brownish, $19-32 \times 3\frac{1}{2}-4\frac{1}{2} \mu$, usually curved more in one half than in the other. The acervuli are found in the red spots and often in the browned portion beyond the spot.

While not a typical *Cryptosporium* this fungus fits better there than in *Septoria*. Its intimate association with the "red spot" is ground for suspecting causal relation. If it be the cause of the spotting and browning of the pine foliage, it is an important economic fungus. *Oligostroma acicola* Dearn., *Mycologia* 18: 252, may be an ascigerous relative.

***Cylindrosporium sibiricum* Dearn. & Bisby, sp. nov.**

Spots amphigenous, similar, red-bordered in the green leaves, blue-gray in the yellowed ones, circular, small, 1-3 mm., becoming irregular. Acervuli numerous and minute as if issuing at almost every leaf-stoma, later marked by fewer, large amphigenous cirrhi. Conidia hyaline, 1-3-septate, straight or somewhat curved, $22-45 \times 2.75-3.25 \mu$, mostly about $30 \times 3 \mu$.

On living leaves of *Apocynum sibiricum* Jacq.; Pierson, Man.; June 30, 1921. V. W. Jackson. (D. 5661.)

***Cryptosporium Boycei* sp. nov.**

Acervuli scattered, seated in the cortex, not reaching or marking the wood, nearly circular, .5-1.5 mm. in diameter, .5-.8 mm. high, encinctured by the upturned epidermis and rising at most 280 μ above the surrounding bark; surface pulverulent-yellow-gray when fresh, becoming dull gray-brown, the basal layer either simply lining the cavity or by invaginations appearing locellate. Conidiophores $20-90 \times 2.5 \mu$, usually curved at the tip after the conidia are discharged, and like the layer from which they arise yellow in the mass. Conidia hyaline, yellow in the mass, acuminate-acute at each end, crescentic, curved to a semicircle or strongly falcate, sometimes incurved at the outer end, 3-septate, $45-75 \times 3.5-5 \mu$.

Producing a canker on languishing branches and small trunks of *Pseudotsuga taxifolia*; Stanley Park, Vancouver, B. C.; Aug. 24, 1924. North Bend, King Co., Wash.; July 31, 1927. J. S. Boyce: 1285, 1766. In *Herb. U. S. For. Path.* 40,394. (D. 5666.)

Dr. Boyce studied this fungus in King Co. on a stand of Douglas

fir reproduction averaging about 10 feet in height. He found that trees showing winter injury—parch blight—were generally more or less cankered, in some instances from the top nearly to the root, and that on the severely injured and dead bark the fungus was fruiting abundantly. He concluded that it attacks only the injured or weakened trees and that there was no evidence of perennial progression into the healthy tissues.

Libertella ulmicola Dearn. & Barth. sp. nov.

Acervuli large, irregular, up to 1 cm. long, sometimes nearly as wide and sub-circular, in the liber of elm posts. Conidia hyaline, $15-24 \times 1 \mu$, issuing in large yellow or orange wedges, up to 1 cm. by 4 mm.

In the bark of *Ulmus americana*; Stockton, Kan.; March 1925. E. Bartholomew: 9023. (D. 5882.) *L. Ulmi-suberosae* Oudem. has different spores.

LONDON, ONTARIO,
CANADA

NOTES AND BRIEF ARTICLES

Professor A. H. Chivers, head of the Department of Botany in Dartmouth College, has recently spent a semester on sabbatic leave in the Department of Plant Pathology in Cornell University.

Guy West Wilson, for several years Professor of Biology at Upper Iowa University, Fayette, Iowa, has been appointed and served during the year as Professor of Botany at Penn College, Oskaloosa, Iowa.

Dr. B. O. Dodge, who has been for the past eight years pathologist of the Bureau of Plant Industry of the United States Department of Agriculture, has accepted an appointment as plant pathologist of The New York Botanical Garden and began work at the Garden on May 1st. Dr. Dodge was assistant and instructor in the Department of Botany of Columbia University from 1909 to 1920.

In "The Rusts and Smuts of Bermuda" by Whetzel and Jackson the statement is made regarding *Entyloma Meliloti* McAlpine on *Melilotus indica*: "The species appears to be common on this host everywhere in the islands during the spring months; known otherwise only from Australia." *Trans. British Mycological Society* 13¹: 6 (1928). The parasite was found on this host at Auburn, Alabama, in March 1921 by J. F. Duggan.

J. J. DAVIS

Manuscript is coming in so much more rapidly than it can be published in MYCOLOGIA that contributors are requested to cut down their articles to the briefest possible form. They are also requested to use greater care in citations to literature, making

them brief and consistent and, thereby, economizing the time of the Editor and increasing the likelihood of an early publication of the contribution.

Following the publication of my article in the March-April issue of MYCOLOGIA, Mr. E. W. Mason of the Imperial Bureau of Mycology, Kew, England, calls attention to the following facts pertaining to *Sphaerostilbe longiascus* Möller which is there regarded as a synonym of *Macbridella striispora*: The genus *Calostilbe* was established by Saccardo and Sydow (Sylloge Fung. 16: 591. 1902) for Möller's species, which was made *Calostilbe longiasca* (Möller) Sacc. & Syd. Since this species is synonymous with our species, *Macbridella striispora* becomes ***Calostilbe striispora*** (Ellis & Ev.) comb. nov. This genus takes from *Macbridella* the forms with the stilbaceous conidial stage. FRED J. SEAVER.

The North American Cup-fungi

(Operculates)

ADVANCE NOTICE

The above work, which has been in the course of preparation for a number of years, is well under way and is expected to appear within the year, unless delayed by some unforeseen difficulty. It is estimated that the book will comprise 250 pages or more of text, forty-six plates and a number of text figures, and will sell for five dollars. There is no other monograph of this group of fungi in America and, while this is not being offered as the "last word" on the subject, it is, at least, the beginning of a more complete knowledge of these interesting forms of plant life. That there is need of such a work is indicated by the fact that one hundred advance orders were placed within thirty days after the project was announced, and that without any advertising other than a few circular letters sent out each morning in the course of the day's routine. As the size of the edition will be regulated somewhat by the rapidity with which advance orders are received, institutions and individuals wishing copies should place their requests at once. FRED J. SEAVER.

Gäumann's Comparative Morphology of Fungi

American students of mycology will welcome the appearance of the English translation of Professor Albert Gäumann's "Comparative Morphology of Fungi" prepared by Dr. Carroll W. Dodge of Harvard University. The German edition of this work appeared in 1925 and has been much used by advanced students in the larger universities of this country. The English edition by Dr. Dodge will make it much more accessible and highly prized as a text.

While it is a translation, as stated by the translator, it is a loose translation of the German, and an attempt has been made to correct some of the misconceptions of the original author, as well as to incorporate much information of a morphological nature which has come to light since the German edition appeared, so that it is really much more than a translation.

The book, which is put out by the McGraw-Hill Book Company of New York City, consists of 701 pages of text and 406 text figures. A copy of this work should be in every mycological library. FRED J. SEAVER.

Book Review

Late in 1927 there came from the press a book that will prove interesting to all American students of the fleshy fungi. It is entitled "Mushrooms and Toadstools" and is written by Messrs. H. T. Güssow and W. S. Odell of the Dominion Experimental Farms, Ottawa, Canada. The preface states that the book "is not intended as a 'learned treatise,' but is meant to appeal to students as well as nature lovers." The book comprises a total of 274 pages, with special chapters on the general structure and development of fleshy fungi, the use of them as food, poisoning by mushrooms, and a brief account of mushroom culture. Rather complete descriptions are given of about 160 species of fleshy fungi commonly found in Canada. While this list is small in proportion to the number of species that must occur in a region of the extent covered by the book, yet for the amateur collector and the mycophagist it will be found to fill a definite need. The illustrations presented are ample, consisting in all of 128 half-tone

full-page plates that must be conceded to be the best half tones produced in any similar work in this country. Not the least attractive feature of the book is the price. It may be obtained from or through either of the authors for the price of one dollar.

That it cannot be used as a complete manual, and was not intended to be so used, is indicated by the fact that but seven species of *Clavaria* are included, four of *Hydnum*, and eight of *Boletus*. Yet even the advanced mycologist will find the illustrations of value, and the book is attractively bound and will grace any bookshelf. Errors due to misdeterminations seem to have been entirely eliminated—at least none have been noticed by the reviewer. In general the book is a distinct credit to its authors and they are to be congratulated in presenting us with a volume of this type. L. O. OVERHOLTS.

